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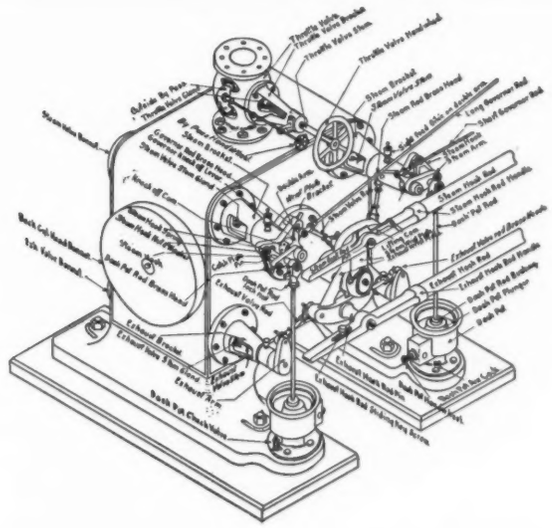
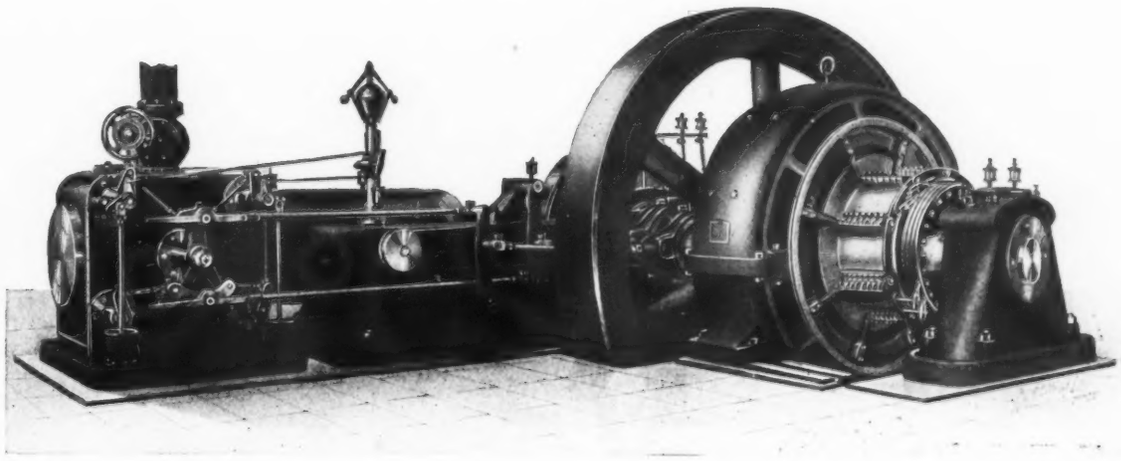
POWER AND THE ENGINEER

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY, 505 PEARL STREET, NEW YORK.

Vol. 29. Index to Advertisers and Classified Index Following Reading Matter. No. 6



Pamphlet No. 7, containing a number of drawings similar to the above, will be sent on request of subscribers to Power and The Engineer.



A picture in colors of the above engine, measuring with mat 9 x 13 inches, will be sent to the first 1000 engineers in charge of power plants who write promising to frame and hang it in their engine rooms.

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Incorporated Feb. 1, 1870

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Skeptics Become Enthusiastic About The Dean Boiler Tube Cleaner

Over and over again we have said: "The strongest argument we have in favor of the DEAN is the DEAN itself."

There isn't a single objection or prejudice against the tool that a thorough test of it won't prove to be groundless.

A case in point is the WASHINGTON POWER CO. of WASHINGTON, KANS. Two weeks after they had ordered a DEAN on trial, they wrote: "We are on the fence now, as the Inspector for the ——— Insurance Co. was here today and condemned your cleaner. He says that it will damage our flues if we use it, and advises us to return it without trying it on the boiler."

A DIFFERENT STORY AFTER THE TEST.

A month later, June 4, 1908, they wrote:

Replying to your letter of the 2" in regard to the DEAN CLEANER, will say that there was a number of the directors of the company greatly opposed to the purchasing of your cleaner until we gave it a trial.

We used it last week on one of our boilers and the work it accomplished can only be comprehended by seeing the pile of scale we got out of our boiler.

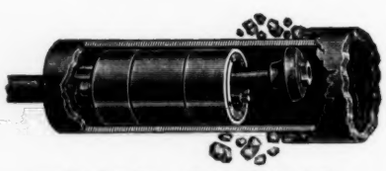
We first went in the boiler and picked off all the scale we could by hand and thought it was in pretty good shape; then we started the cleaner to work and the amount of scale we got the second time was more than we were able to pick out in the beginning.

We have won the approval of all the parties that saw what we could do with it; and another point is that our flues were in bad shape and all reinforced at the back to keep them from leaking and after we were through cleaning we expected to see the old boiler leak a stream but there was no more show of a leak after we had used the cleaner than there was before.

Yours truly,

Washington Power Co.

By O. A. Wells Mgr.



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Don't you want to give this CLEANER a test in your boiler? We'll loan it to you for the purpose, free of charge.

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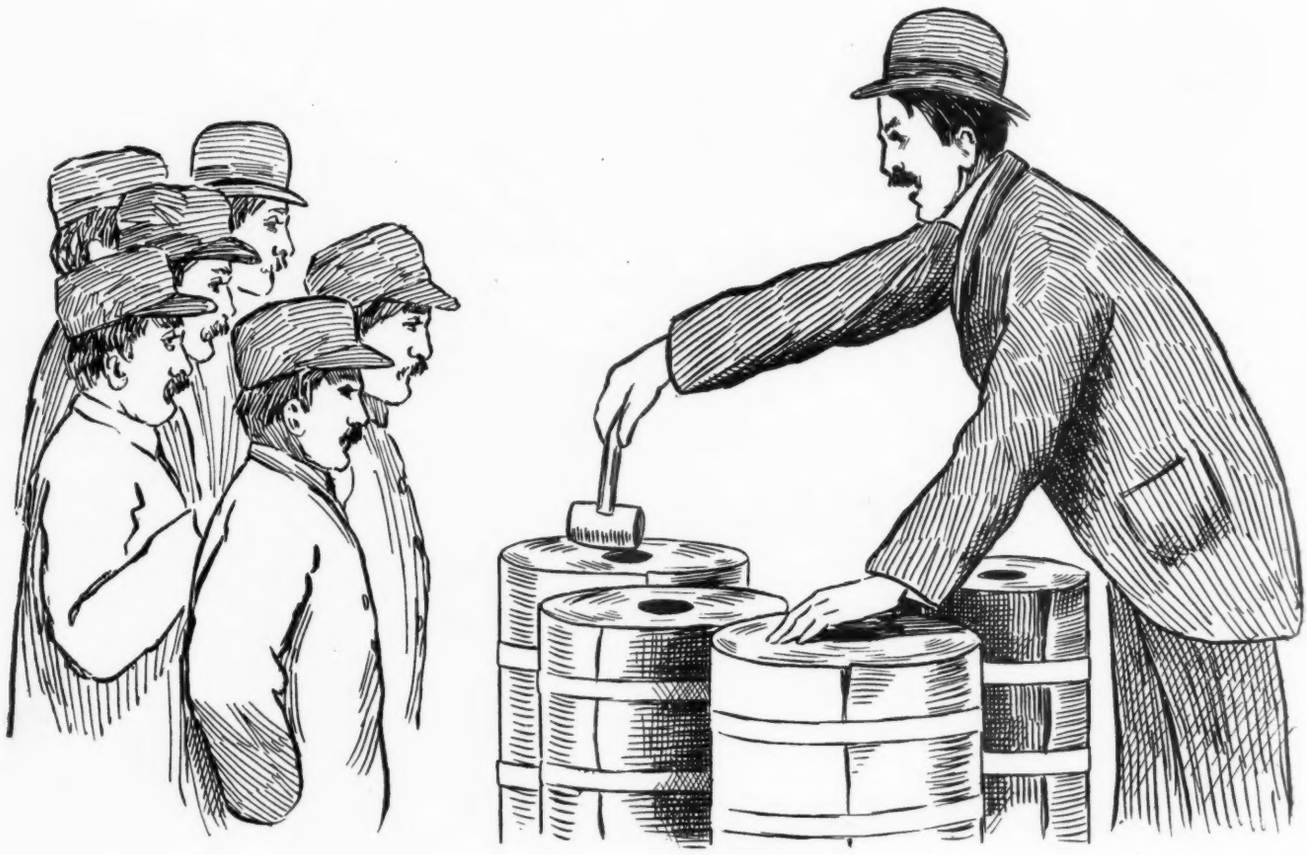

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Now, gentlemen, step up closer, please. I am going to offer you something special—something you want. This celebrated Before-The-Flood packing. There's quality in every inch, gentlemen, in every inch! Now, what am I offered a pound? Ten cents? What? Ha! Ha! Well, let her start at that. Now, boys, ten cents, ten cents. Who'll make it fifteen? Come boys, I can't make a sale on one bid. Who'll make it fifteen? No offer? Then we'll have to pass it up.

I guess, boys, you're out for something choice. Well, here it is, the choicest ever! A black sheet packing that's a Cracker-Jack. What's that? Is it Ebonite? Well, no, but I guess it's just as good." (Chorus of voices) "There is no packing that's just as good as EBONITE Black Sheet Packing. We know! We've tried Daniel's EBONITE for superheated steam, high steam pressures, hot and cold water, oil, ammonia, gas, and everywhere you can use a packing, and there isn't anything that can touch EBONITE."

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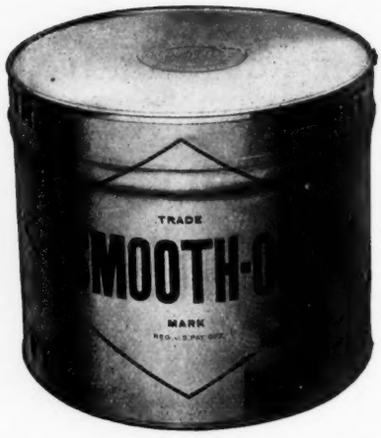

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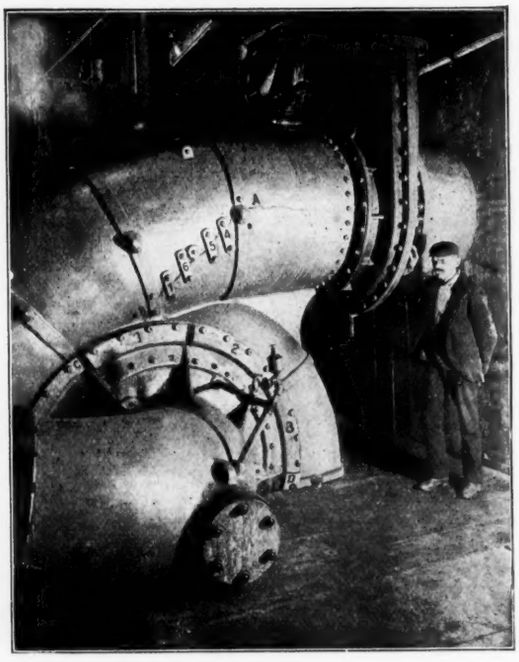

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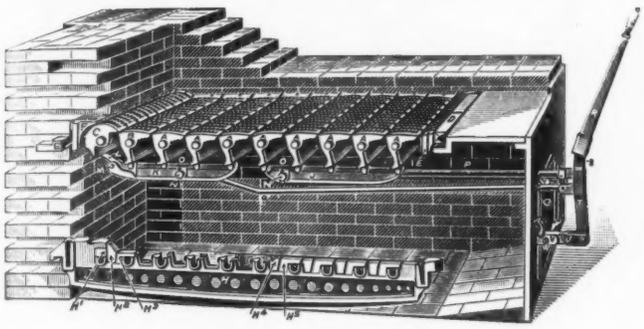
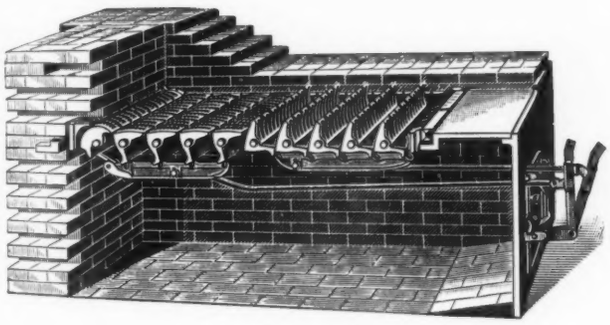


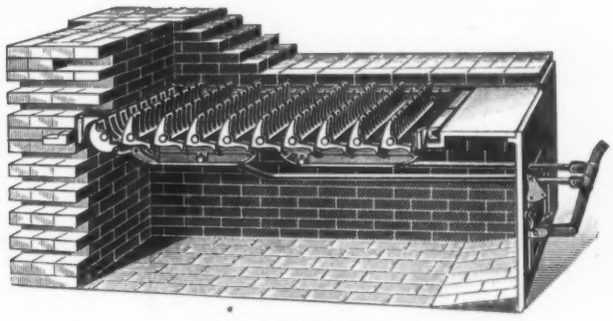
Normal Position of Grate

Shaking Movement

There's Money And Heat In Cheap Fuel



Divided Cut-Off



Whole Cut-Off Movement

The McClave Grate And Argand Blower

offer the ideal system for *completely consuming* all such low grades of fuel as anthracite birdseye, rice, bituminous slack, screenings, duff, etc. Every heat unit is extracted, no waste fuel is allowed to fall into the ash pit and the same results are obtained as if high grade fuel were used.

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1st—It will work on higher pressure and handle hotter water.

2nd—It will lift further vertically on a greater range of pressure.

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Try the PENBERTHY it never fails.

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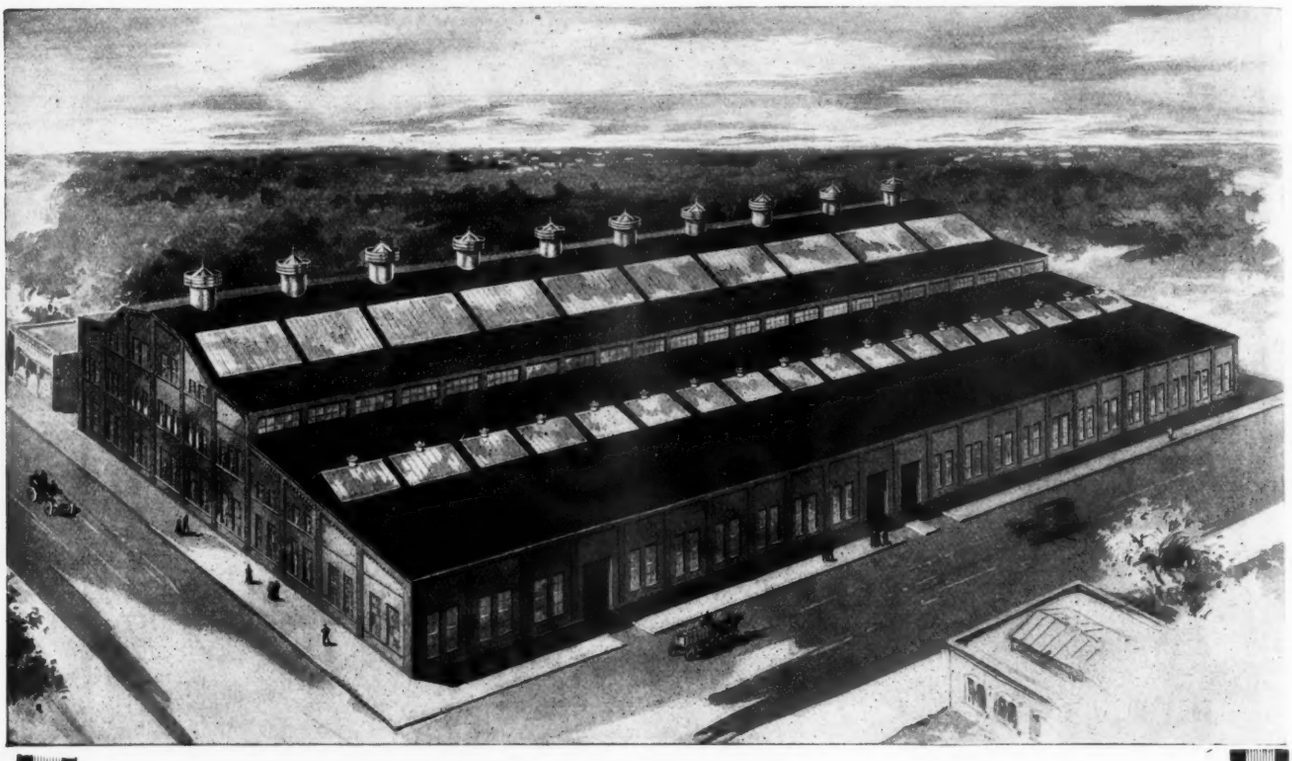

Metal top with sliding-sleeve damper patented).

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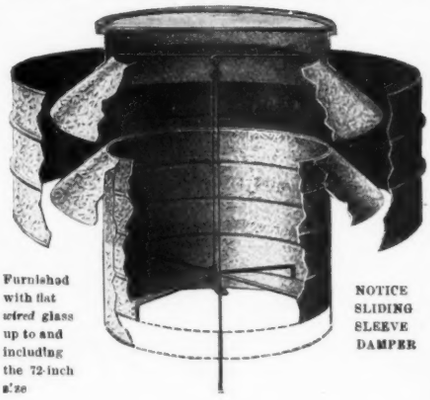
30 BURT VENTILATORS

These devices insure best atmospheric conditions in the factory because they positively draw out of buildings all impure air, smoke, steam and gas, and this with no expense for operation. They are strong, heavily built, durable and stormproof, and are made with either metal or glass tops, the latter acting as sky-lights. To keep a building supplied with pure air less "Burts" are needed than any others.

The Jones & Lamson Machine Co., uses 80 "Burts;" The Yale & Towne Mfg. Co., 20; The Florida East Coast Ry., 48. Additional list of users upon request.

Send for our 92-page Catalog.



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Largest manufacturers of oil filters in the world. Geo. W. Reed & Co., Montreal, Sole Mfrs. of "Burt" Ventilators for Canada.

Great Northern Power Company's Plant

Hydraulic Turbine Installation in Northern Minnesota; Some of the Operating Features; Description of the Great Dam and Waterways

BY CLAUDE AIKENS

During more than 30 years the development of a great water power for supplying the manifold industries at the head of Lake Superior has been seriously considered, and numerous projects, based on the improvement of the St. Louis river, were put forth at intervals; but not until the formation of what is now known as the Great Northern Power Company did any of the plans assume practicable shape.

With its tributaries the St. Louis river drains a territory of about 3700 square miles situated on the great elevated plateau of northern Minnesota, flowing in the upper reaches in a general westerly direction and gradually changing its course to south and southeast until it enters Duluth harbor at Fond du Lac, Minn., after describing nearly a half-circle in a length of about 150 miles. During this entire course a descent of 1150 feet is made, but there are no rapids or falls suitable for water-power development until Thomson, Minn., is reached, or about 10 miles above slack water. From this point the river falls 464 feet in eight miles over a series of rapids, and near the head of these the Great Northern Power Company has constructed a concrete dam 38 feet high and 1120 feet long, with a spillway 368 feet long and 6 feet deep. An additional spillway 1000 feet long was also formed by dressing off the top of a natural ridge of slate rock.

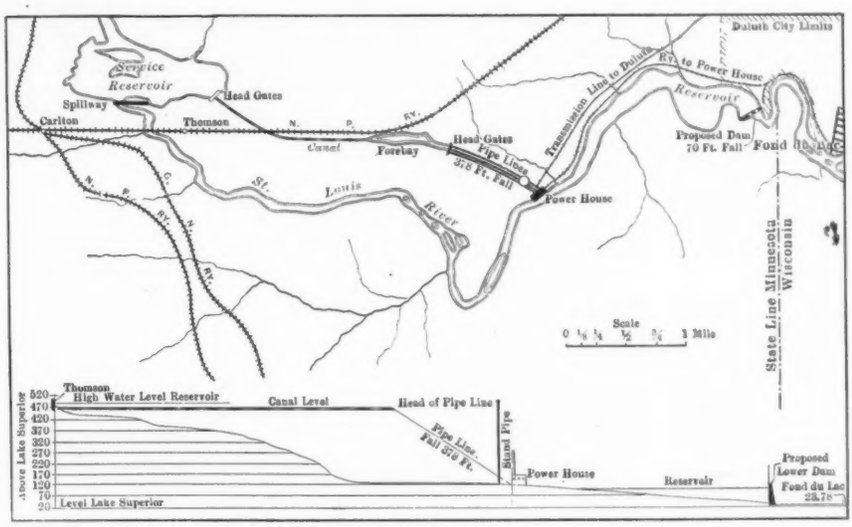


FIG. 1. GENERAL LAY-OUT OF ENTIRE DEVELOPMENT

The dam forms a service reservoir of about three-fourths of a square mile in area, at the southeast corner of which is located another concrete dam with racks and head gates to admit water to a canal two miles long, 70 feet wide and 15 feet deep, which ends in a forebay covering 40 acres.

Located near the village of Thomson and 464 feet above Lake Superior, the service reservoir has a gross capacity on its 12 feet of available draft of 130,000,000 cubic feet of water, which is amply sufficient to accomplish the purposes of conservation and regulation. The reservoir is about 1½ miles by ½ mile in surface area, and the greater portion of its bounding walls on the lower sides is of upturned slate. A main dam was built across the channel, with a dozen low dams of earth, rock with concrete core and concrete, connecting the slate walls. Most of the latter are concrete retaining dams of the gravity type. The main dam is of concrete, and is 110 feet long; its spillway section is 365 feet long, 40 feet high and 42 feet wide at the base. In this part of the dam are three sluiceways with gates 7x9 feet, controlled by stems passing up into covered gate houses.

FIG. 3. THE DAM AT CLOSE RANGE

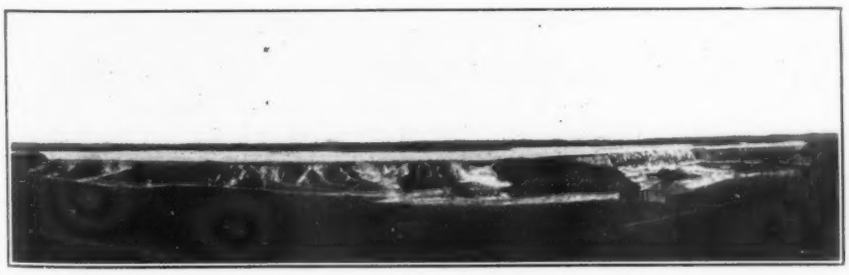


FIG. 2. MAIN RESERVOIR, DAM AND SPILLWAY

In order to form an ample spillway for the maximum floods of the river, a section of the slate ridge has been cut off

to 18 inches above the level of the spillway section of the dam. This opens above a small creek, which flows into the main river below the dam. On account of the fact that the maximum flood of the river has been as high as 50,000 cubic feet per second, or 100 times the minimum flow of deficiency seasons, this precaution is considered necessary. One of the dozen dams around this service reservoir is a segment of a circle, whose arc is 100 feet. It has a clear span of 60 feet at the crest and is 60 feet high at the deepest point. The space to be dammed and the configuration of the ground made such a form of wall most economical.

The service reservoir has an important function in clearing the water from needle ice. No anchor ice has ever been observed in the river. At the discharge of the service reservoir and forebay are curtain walls with submerged arches through which the water flows. These are of ample section to make the current passing through them quite slow. It is a fact that while the entire surface of the service reservoir may be covered with bark, chips and other débris from saw and pulp mills above, the water coming out of these arches and flowing along the canal toward the power station is perfectly clean, although the rack screens in the reservoir are coarse. Another series of curtain walls, submerged arches and a finer rack will perform the same duty at the lower end of the forebay.

FIG. 4. CANAL OPENING INTO FOREBAY

FIG. 5. WOODEN-STAVE PIPE LINES

The Canal and Forebay

The canal into which water from the service reservoir passes is 8500 feet long and has been excavated for its entire length in the slope of a hillside. For a mile it runs through clay and occasional rock ridges, the remainder of its length being in a slate-rock section with some earth interposed. The limiting conditions of construction of the earth section were the required capacity of the canal, or sufficient water to supply 80,000 horsepower at the power house, and erosion of its banks based on a flow of water of 3 feet per second. In order to harmonize conditions it was planned for a cross-section 36 feet wide at the bottom, a depth of 15 feet and slopes of 2 to 1. It was originally intended to line the entire earth excavated canal with concrete, which would have lessened the grade and diminished the cross-section, but this plan was changed and the base of the earth canal was built 66 feet wide and the slopes steeper than originally designed, in part because the work was done by a steam shovel and the wider cut was cheaper. In the rock-hewn parts the cross-section is in no place less than 450 square feet, though somewhat irregular. The Northern Pacific Railroad crosses the canal on a plate-girder double-track bridge of 70-foot span on concrete abutments. As a protection to the forebay embankment, which is an earth mass of some 500,000 cubic yards, there is a canal spillway of concrete 200 feet long to discharge into a stream flowing into the river below.

At the foot of the forebay another concrete dam, with racks and head gates, has been erected, and from this start the 7-foot penstocks, one of which has been installed for each water-wheel. This pipe line is 5000 feet long, the upper 4000 feet being of wooden stave construction and the lower 1000 feet of riveted steel leading down over a steep bluff to the power station, which is located on the river bank below, giving a working head of 378 feet. It will be noted that the three miles of canal and pipe line cut off five miles of the river, which here makes a curve, the most important of the rapids being in this curve.

The wood pipe is built of clear redwood timber staves, each stick forming its proper arc of the 7-foot circle of the line. The staves are tied by ¾-inch steel rods with malleable shoes and turnbuckles and spaced along the pipe in accordance with the pressure. The staves are made continuous along the length of the line by metal plates inserted in saw cuts at each end of each stave, and designed to prevent leakage. Each wood pipe at its foot passes into a cast bell-shaped section of the steel line, where it is thoroughly calked with lead and oakum. There are similar sections at the upper ends of the wood pipes. The steel pipe is made of plates which are thoroughly riveted and were dipped into hot asphalt when laid. The entire line is laid in a covered trench, and at its lower end the pipe is anchored in concrete built up from bed-rock beneath the power house. Although the grade of the line is continuously down, automatic air valves have been placed at points where there is a variation in grade, to prevent any possible tendency toward the formation of a vacuum due to sudden changes in the rate of flow of the water. Under normal conditions the pipe lines deliver water at the rate of 335 cubic feet per second, equivalent to 10,000 electrical horse-power. The friction loss is equivalent to about 10 feet of head, and that in the canals when running full is about 6 feet more.

At the top of the bluff above the power house the pipe lines are connected to a cross receiver. From this rises a 6-foot stand-pipe connecting with a tank 30 feet in diameter and 52 feet high, the top of which is 250 feet above the foundation of the structure and slightly above the level of the forebay. The stand-pipe is for the purpose of maintaining an even pressure in the pipe lines and to prevent a surge due to sudden increase in load; the total quantity of water contained in the pipe, receiver and tank will be 312,000 gallons, weighing 1300 tons, and 260 tons of steel were used in the construction.

The Power House

Water is carried into a fireproof building ample for four wheels and designed as about half of what will be erected when the entire portion of the company's development at this point shall have been called for. It is now 77x181 feet in area and when completed it will be 313 feet

long and will contain eight generating units, each unit consisting of one 13,500-horse-power vertical reaction turbine built by Allis-Chalmers Company, with a 7500-kilowatt vertical three-phase 25-cycle generator, capable of developing 25 per cent. overload for three hours and mounted upon the turbine shaft.

These turbine units are the most powerful ever put into service. The running portion of each wheel is 62 inches in diameter, and their speed is greater than any other wheels of such size. For the ultimate capacity of the plant the storage reservoirs planned, the service reservoir, canal, forebay, etc., already built, are sufficient, and to increase to this limit there need but be added single units of pipe line, wheel and generator and distributing system to the amount desired.

Between the power house and slack water, three miles below, the river falls 70 feet, so it is proposed to build another dam and power house later at the head of navigation, backing the water up to the level of the tail water at the main power station and obtaining an additional 20,000 horse-power. The Great Northern Power Company owns all of the water rights involved in both developments.

The Turbine Water Wheels

In a high basement of the power house are the penstocks, turbines, pumps, etc., and on the floor above them are three

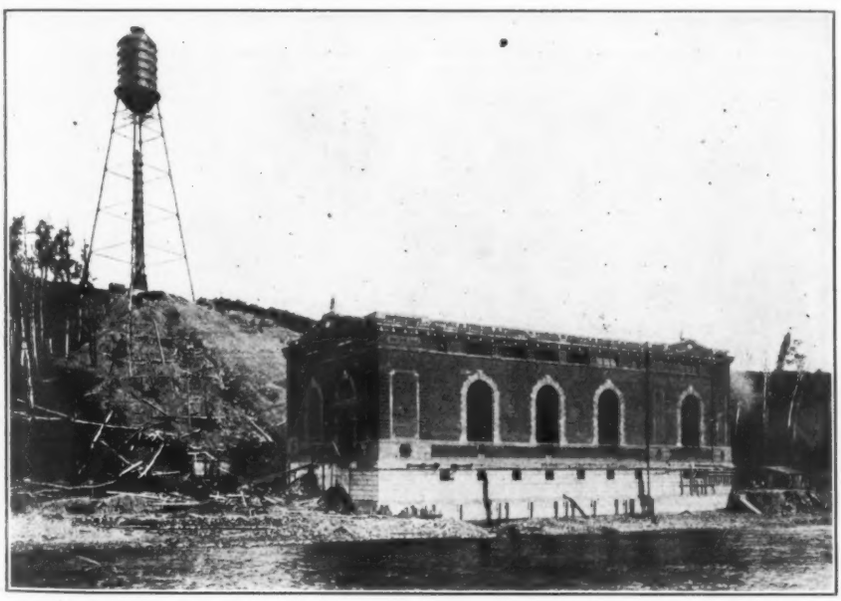


FIG. 6. POWER HOUSE ON THE ST. LOUIS RIVER

generators and their exciters, with room for another wheel. The turbine water-wheels, each of 13,500 horse-power rated capacity under the available head of 365 feet and known to be capable of running up to 18,000 horse-power, have vertical shafts, are directly connected to the generators above and are of the Francis high-pressure type, the wheel operating at 375 revolutions per minute. Penstocks laid on the floor of the basement connect them with the 7-foot pipe lines, the water column being gradually reduced from 84 inches at the junction of the penstock with the pipe line to a diameter of 66 inches at the wheels. In each penstock is set at the 66-inch section an hydraulically operated gate valve, which is the largest ever constructed for such pressures. They weigh

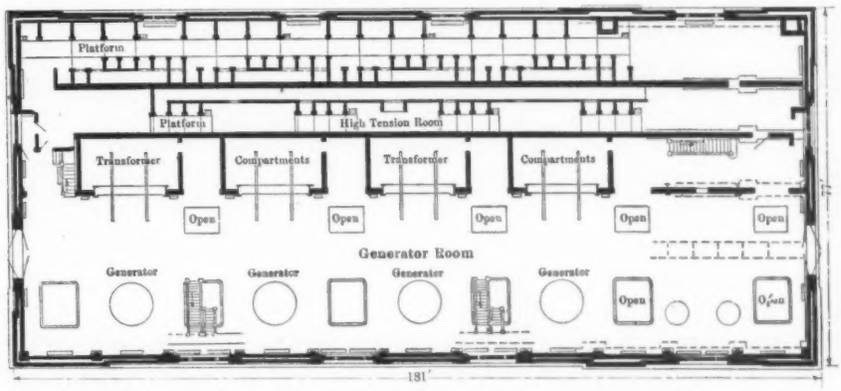


FIG. 7. PLAN OF POWER HOUSE

31 tons each and occupy a floor space 28 feet long.

Two 24-inch pressure regulators are placed on each penstock between the 66-inch gate valve and the turbine which the penstock serves. These pressure regulators are arranged so that they can be operated automatically by a governor on the turbine, and they can also be set to open when the pressure in the penstock rises above a predetermined amount. Each regulator is fitted with a dash-pot having a time-element release that closes the valve gradually and automatically after the pressure is relieved, in order to reduce the waste of water. As these pressure regulators are operated in multiple through the cross receiver at the standpipe, if one of them fails to work the remaining five will still be in service to meet the necessity for a relief of pressure. When the four additional main units are placed, this multiple operation of the pressure regulators will be further improved.

Of each turbine the penstock terminates in a large tapering spiral casing, the cross-section of which is circular, the case being built on a spiral so as to surround the runner of the wheel. This spiral casing is a steel casting made in two parts, having a combined weight of over 83,000 pounds. Water is admitted to the runner from every point on the inner side of the case, passing through an annular casting containing fixed guides and through movable guide vanes, or gates, in a second case inside the annular casting. The spiral casing, the annular casting and the guide case are all concentric with the shaft of the wheel. The movable gates turn on a vertical pivot placed in the gate, and the gates are set in a circle concentric with the shaft of the runner, their arrangement being such that they overlap and can be turned to close the opening between them.

Fly-ball Governor Regulation

The quantity of water supplied to the runners is controlled by the position of these gates, which position is determined in the following manner by a fly-ball governor driven by the turbine: The pivots on which the gates are set extend to the top of the guide, or gate case, where they are each connected by a horizontal link with a bolt in a shifting ring, which fits around the case. This ring is arranged to revolve on an axis concentric with the shaft of the runner, but is required to move only a very slight amount in order to close or open the gates. Two heavy links attached at diametrically opposite points on the shifting ring are each connected through a positive motion to the piston-rod of one of two pairs of operating cylinders which are a part of the governing mechanism of the unit.

The two pairs of operating cylinders are placed horizontally, one pair on each side of a yoke over the wheel. The operation of each pair of cylinders is the same,

the cylinders of each pair are arranged in tandem. Each cylinder contains a piston and the two pistons of the pair are connected to one piston-rod. One cylinder of each pair is connected with the penstock, and the other with a high-pressure oil system. The connection with the latter is through a pipe fitted with a valve controlled by a fly-ball governor on the floor of the generator room, this governor being belted to the shaft of the runner of the turbine. The pressure maintained on the oil system is much higher than that in the penstocks, so that when the valve is opened to admit oil to one cylinder of each pair, the pistons in the oil cylinders are pushed ahead against the lower pressure of the water. The two pistons of each pair of cylinders are thus moved, the motion is transferred to the shifting ring by a link attached to the rod connecting the pistons, and through the links on that ring connecting with the pivot of the guide vanes the position of the latter is altered. A reverse motion is obtained by draining oil from the two oil cylinders, which reverse is also accomplished automatically by the governor. One piston-rod also carries a crosshead so it may be connected to the two pressure regulators of the unit by a long lever arm.

The turbines are supplied with water from the penstocks through a ring system of 16-inch pipes. Each leg of the ring is connected with each penstock, and is fitted with valves arranged so either wheel can be supplied from any penstock. The amount of water furnished to either wheel is automatically regulated by a valve operated by a governor, but which can also be controlled by hand. The water is discharged from these wheels into the river through a pipe in the front wall of the building.

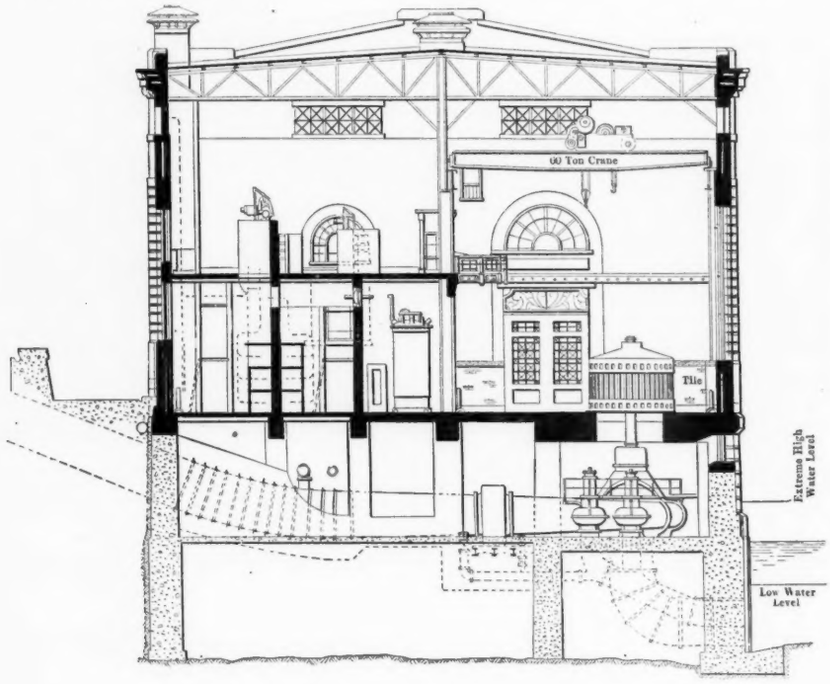


FIG. 8. SECTIONAL ELEVATION OF POWER HOUSE

Oil-pressure Thrust Bearings

Each generator is a 25-cycle three-phase 6600-volt machine. The revolving field is mounted on the vertical shaft of the wheel, and the whole weight of the revolving element of the unit is carried on an oil-pressure thrust bearing on the shaft. A complete system of pipes and pumps supplies oil to the thrust bearings, each unit having an individual oil pump. These pumps are of the mesh-gear type designed for this service, and are two-stage machines, each stage being arranged to raise the pressure of the oil to 200 pounds per square inch, so that the oil can be delivered at 400 pounds per square inch, if desired. The corresponding gears of each stage are on the same shaft, and a Morse roller-bearing chain, which passes over a sprocket on a jack-shaft geared to the vertical shaft of the main unit, drives the pump. The latter takes suction from a central supply tank under the basement floor and delivers into a small, closed, vertical receiver placed over it. One pipe leads from this receiver to the thrust bearing; a second pipe supplies oil to the cylinders of the operating mechanism which controls the position of the guide vanes of the turbine. The drip from the bearing and the discharge from the cylinder are conveyed to a tank fitted with cooling coils through which water from the penstock is constantly circulated, the overflow from this tank being conveyed to the central supply tank by gravity.

Excitation and Current Distribution

Excitation current for the main generators is furnished by two 250-kilowatt eight-pole 125-volt direct-current generators, each direct-connected to a vertical 500-horse-power impulse turbine built by the Allis-Chalmers Company. Each of the generators has sufficient capacity to supply excitation current to all of the eight main units which the station will eventually contain.

The current generated is stepped up for transmission to the sub-station by single 7500-kilowatt three-phase oil-insulated water-cooled transformers, which are 14.88 feet high, 15 feet long and 5.88 feet wide, and contain windings to transform the current to 30,000 or 60,000 volts, as desired. The core and windings weigh about 65 tons and can be lifted bodily out

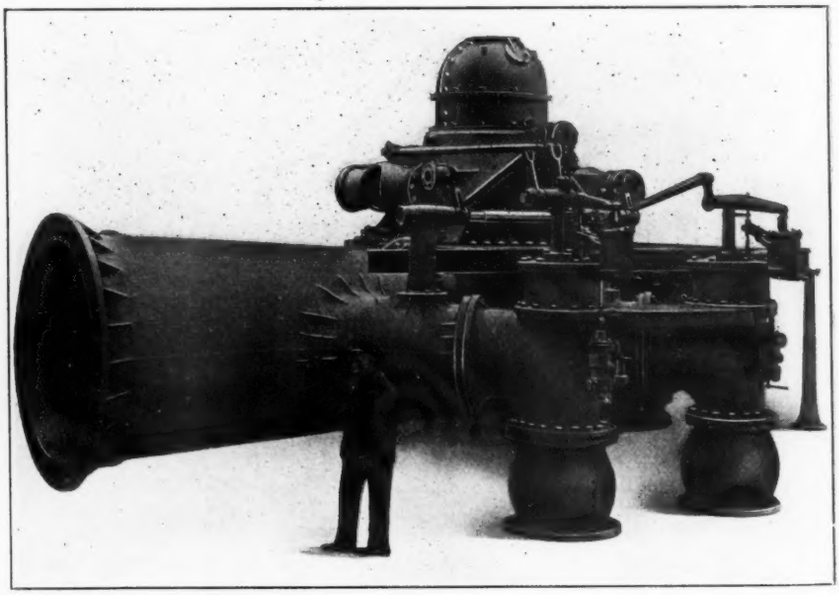


FIG. 9. HIGH-PRESSURE FRANCIS TURBINE, 13,500 HORSE-POWER

of the casing. Surface condensers cool the oil, which is circulated by a special motor-pump set.

Power is carried to the center of consumption over wires placed on steel towers, along a right of way 100 feet wide, the property of the company. These towers are spaced from 300 to 1000 feet

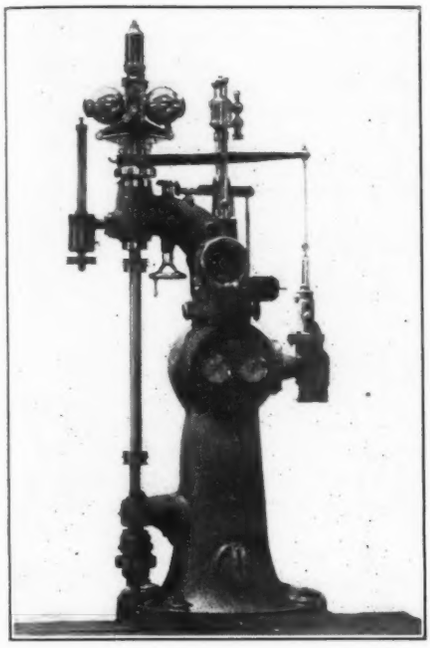


FIG. 10. HYDRAULIC-TURBINE GOVERNOR

apart and are from 40 to 60 feet high, depending on the topography of the country. A voltage of 30,000 is carried on No. 00 six-strand copper cables, and an overhead steel cable is carried on the towers as a lightning arrester, also a telephone line running into insulated booths along the high-tension lines.

street railway. Later, other substations will be built at West Duluth and Superior and provisions made for conveying current to the great iron mines of the Missabe and Vermilion iron ranges, situated at an average of about 70 miles from the power station. Voltage on the transmission lines has been fixed at the high potential mentioned in order that the current may be transmitted this distance.

Notable Features of the Plant

Among the notable features of the installation, in addition to the establishing of large storage reservoirs, are the 7500-kilowatt 60,000-volt three-phase transformers, the largest ever built, the fact that the main power station will develop the greatest amount of power per square foot of station area ever attempted, and the submarine and underground distribution of three-phase current at 13,200 volts. The company now has some 12 miles of cable skirting the harbor and railroad lines, as well as 16 miles of overhead circuits additional to the main feeders from the power station. One of the cables is laid across the harbor to Superior, in a trench dredged 30 feet below water line, or 8 feet beneath the keel of the deepest-laden ship that can pass the Sault river either now or during the continuance of the present Government plan for the improvement of the lakes.

Generalities

The two large power buildings of the company are of most pleasing and substantial design. They are entirely fireproof, being built of steel, brick and concrete, and have steel-frame superstructures set with brick masonry and trimmed with concrete blocks instead of stone. The floors are of steel-reinforced concrete, where they are not heavy arches, and the roofs are of tile covered with asphalt and gravel. The interior of the main rooms is wainscoted in white-enamel brick and finished above with white and buff brick laid in panels between the columns of the steel frames. Other interior faces are in white brick, giving a fine diffusion of light all through the buildings. Traveling cranes of large capacity cover the main units.

The electrical equipment is very complete. In the wiring scheme for the power station all connections between the bus-bars and the units are made through motor-operated oil switches, all arranged

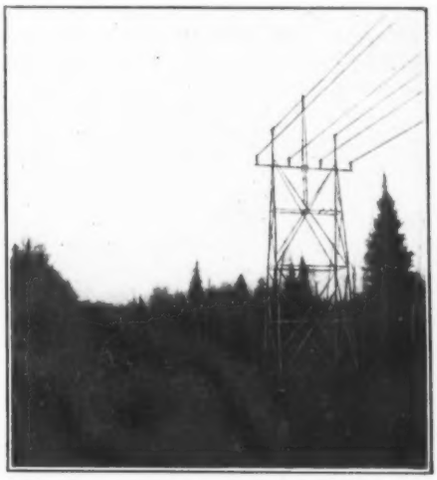


FIG. 12. TRANSMISSION LINE

for distant control from a benchboard placed on a gallery that gives the operator an unobstructed view of the main units. All low-tension wiring is insulated and carried in conduits laid in the floors, while all high-tension wiring is bare and is hung on insulated supports in brick compartments. Throughout the scheme each set of unit wiring can be carried through any transformer and to any one of the transmission lines, and this plan will be continued as the number of units is increased to the maximum. For the control of the entire 80,000 horse-power there is a switchboard that is less than 19 feet long, being unusually compact. In the center of this board is the panel controlling all station lighting and power, and on each side are four panels, one for each of the eight units of the completed plant.

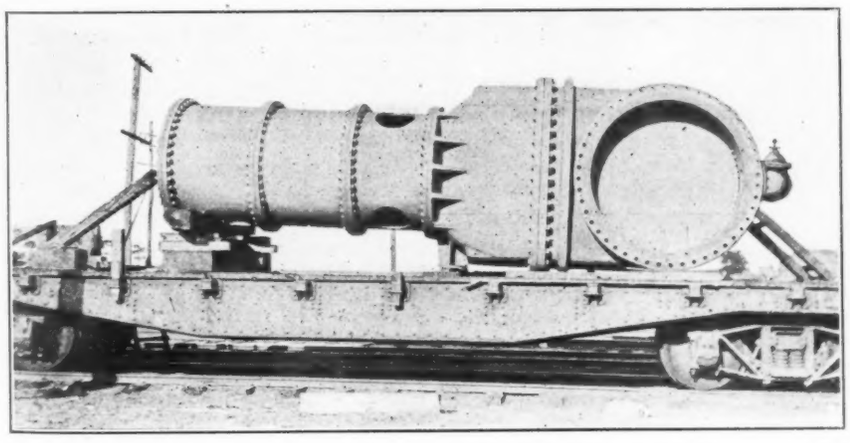


FIG. 11. HYDRAULICALLY OPERATED, 66-INCH GATE VALVE

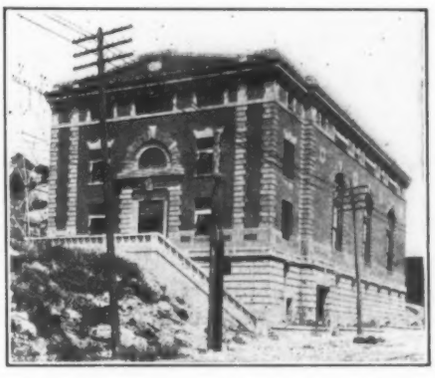


FIG. 13. SUBSTATION IN DULUTH

At Duluth, 14 miles away, is located the main substation, which contains the necessary transformers and switching devices for distributing current at 13,200 volts to the various customers in Duluth and Superior. In this building are located two 1500-kilowatt motor-generator sets for supplying 550-volt direct current to the

Contracts have been made for supplying power to all of the street railways and electric-light and power companies in the vicinity, the pumping station of the Duluth

water works, the American Carbolite Company for the manufacture of calcium carbide, besides many of the large coal docks, iron furnaces and manufactories of various kinds. A large field for power is assured by the fact that Duluth is now the third largest shipping port in the world and thousands of horse-power are used by the immense grain elevators and coal docks, which are the receiving and distributing centers of the great and growing Northwest, while the recent decision of the United States Steel Corporation to erect one of its large steel plants here will result in greater progress being made than ever before in the development of manufacturing in Duluth.

One very important feature of the plans of this company is the establishment of large storage reservoirs on the drainage area, which is practically a wilderness, to equalize the flow of the river, a storage of about 1000 square mile-feet being contemplated. This system, to be established as required, will conserve the run-off and regulate the flow of the catchment area from year to year and season to season. One of these reservoirs has already been constructed, and there is also at the upper end of the present improvement a service reservoir for the regulation of the daily flow, making a pondage to avoid waste of water during short periods. The forebay, moreover, is planned for a regulation into lesser periods of time than the service reservoir permits, averting frequent changes and regulations at the headgates; while near the power house a stand-pipe will act as a safety valve for the regulation of instantaneous changes in customers' requirements. This careful regulation of water supply is necessitated by the extreme fluctuations of the flow and the low minimum of the river.

As a preliminary to the designing of its works, the company was able to secure Government records of rainfall for 37 years, and its own gagings of river flow have been conducted for a period of seven years, these latter including the most abnormal term of rainfall deficiency that has ever been known, ending in the year 1902. At that time there was a year of very low rainfall, coming after four years of unusual deficiency. The minimum flow at the date when the effect of this drouth showed its culmination was but 500 cubic feet per second. The company took this figure, and the period of deficiency which it marked, as the basis for calculating the water storage necessary, after arbitrarily increasing the deficiency by 20 per cent. All estimates of the storage reservoirs required for the ultimate capacity of the plant have subsequently been founded on these figures.

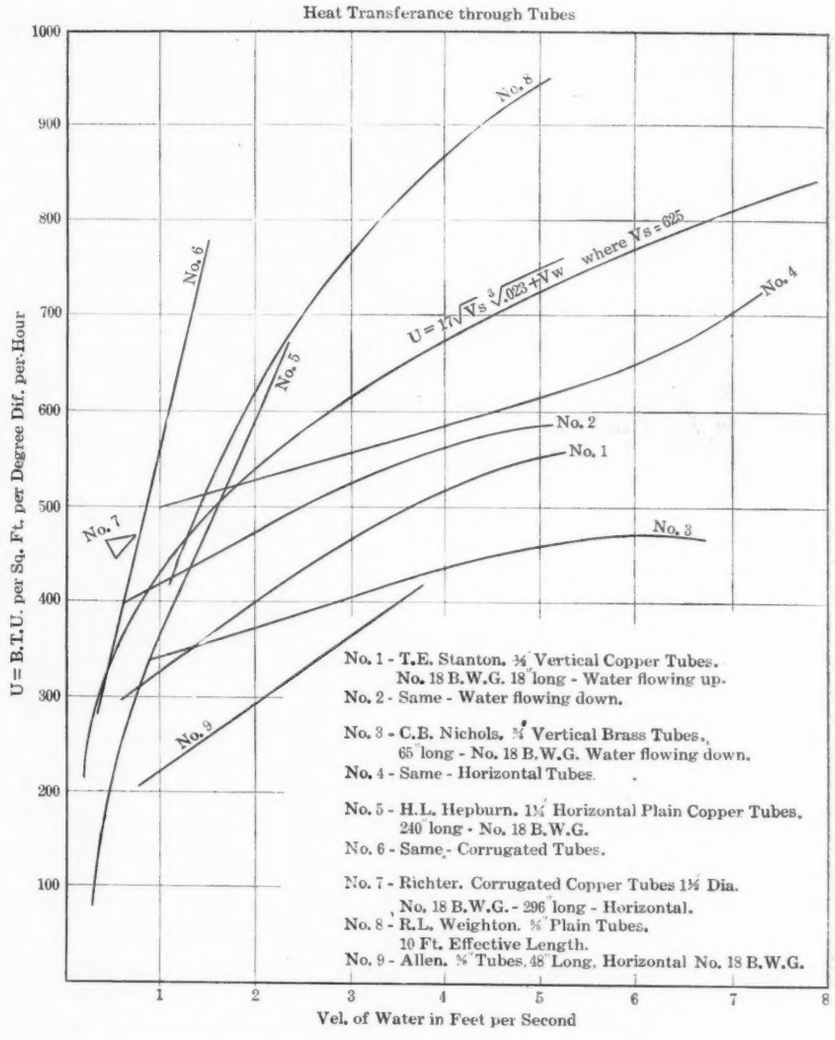
In a double-pipe cooler, one square foot of iron-pipe surface will transmit 100 B.t.u. per hour per degree Fahrenheit difference between the ammonia and the brine.

The Modern Surface Condenser

By George A. Orrok

The surface condenser, originally used by Hall in the early days of marine work, to save the water of condensation for use as boiler feed-water, then thrown into disuse because of the action of the tallow, then used for lubrication, on the tubes of the condenser and boiler, has been for many years a standard piece of apparatus on shipboard and in the power plant. Strange to say, until lately it has not participated in the improvements which have been made in the steam engine, probably because of the lower vacuums necessary for best economy in reciprocating plants; but with the introduction of turbines, the advantages of a high vacuum have been appreciated, and the attention of the engineer has at last been called to the surface condenser, with the result that the box full of tubes, working well ordinarily, has been replaced by a logically designed condenser capable of doing its work in a manner suitable for the high vacuum demanded by the turbine builders, and acceptable to the investor.

Formerly, notwithstanding the experiments of Peclet, Weiss, Donkin and others, it was considered that six pounds of water condensed per square foot of surface per hour was very good work, and most condensers were designed on about this basis, except in marine work, where a slightly larger rate was often used. With the advent of the turbine, the early condensers were designed on this proportion, and even at the present time there are manufacturers who are selling surface instead of using the available knowledge to design a proper and consistent machine for condensing steam.


Heat Transferance through Tubes
U = B.T.U. per Sq. Ft. per Degree Dif. per Hour
Vel. of Water in Feet per Second
1000
900
800
700
600
500
400
300
200
100
1
2
3
4
5
6
7
8
No. 8
No. 6
No. 5
No. 4
No. 2
No. 1
No. 3
No. 7
No. 9
U = 1.1 √Vs ∛.023+Vw where Vs = 625
No. 1 - T.E. Stanton. ¾" Vertical Copper Tubes. No. 18 B.W.G. 18' long - Water flowing up.
No. 2 - Same - Water flowing down.
No. 3 - C.B. Nichols. ¾" Vertical Brass Tubes. 65' long - No. 18 B.W.G. Water flowing down.
No. 4 - Same - Horizontal Tubes.
No. 5 - H.L. Hepburn. 1¼" Horizontal Plain Copper Tubes. 240' long - No. 18 B.W.G.
No. 6 - Same - Corrugated Tubes.
No. 7 - Richter. Corrugated Copper Tubes 1¼ Dia. No. 18 B.W.G. - 296" long - Horizontal.
No. 8 - R.L. Weighton. ¾" Plain Tubes. 10 Ft. Effective Length.
No. 9 - Allen. ¾" Tubes. 48" Long. Horizontal No. 18 B.W.G.

SHOWING HEAT TRANSFERENCE UNDER VARYING CONDITIONS

The earlier researches of Peclet, Weiss, Ser and other European investigators on the rate of transmission of heat through tubes, were carried to their conclusions in the development of the sugar industry, and the various factors thus established may be stated as follows:

(1) The rate of heat transmission through a tube is nearly directly propor-

tional to the mean difference of temperature between the liquid on the inside and the vapor on the outside of the tube.

(2) The rate of heat transmission is proportional to the square root of the velocity of the vapor normal to the line of tubes.

(3) The rate of heat transmission is proportional to the cube root of the velocity of the water in the tube.

(4) Dirt on the outer or inner surface of the tube largely cuts down the transference of heat.

The experiments of Stevens (unpublished) established that the material of the tube had, within limits, no effect on the heat transference.

The investigations of Nichols, Stanton, Hepburn, Allen and others have given values to this heat transference; and in 1906, Weighton, in a paper read before the Institution of Naval Architects, confirmed most of the above results, and added the following important points:

(1) Condenser tubes flooded with water, or those from which the water does not drain quickly, may have their heat-transferring qualities reduced to practically nothing, due to the fact that the difference of temperature between the inside and outside of the tube is cut down.

(2) Tubes may be air-bound, i.e., covered with a thin shell of air, preventing the vapors from coming in contact with the cold tube.

Both of these points were somewhat anticipated by Stanton, who unfortunately used a vertical-tube condenser in most of his experiments, and so failed to appreciate the point.

Weighton also described a method of design which he called the contraflo-condenser, the principle being identical with Weiss' counter-current condenser, but having in addition certain arrangements to prevent the flooding of the tubes with condensed water. This type of condenser is now being built by a number of manufacturers, and is rapidly taking the place of the older types. The accompanying diagram shows to good advantage what may be expected in the way of heat transference under various conditions.

Deleterious Effect of Air in the Condenser

Recently the attempts at a high vacuum have called attention to the deleterious effect of air in the condenser, and the problem which Weiss had worked on and partially solved by the addition of a dry-air pump, has been investigated again by Stanton, Smith, Parsons, Weighton and others. D. B. Morison, before the Institute of Naval Architects (April 9, 1908), has presented a paper in which he gives the results of a series of investigations along this line, together with drawings of several late condensers for high vacuums, which have been very successful.

In this country, a few large installations have been made in which this principle was adopted, and exceedingly good results have been obtained. It is unfortunate that results of investigations made here have been usually treated as trade secrets, and the profession as a whole has had to learn of the advances in the art of condenser design from across the water.

It has been customary, in designing condensers, to allow a certain number of square feet of surface per horse-power or per kilowatt, irrespective of vacuum, or else to increase the surface for higher vacuums; although Seaton, at least twenty years ago, with his customary sound reasoning, recommended a decrease of surface for the higher vacuums. The cost of pumping circulating water was given undue prominence, and very few condensers were given sufficient water for economical operation. The air was almost always removed by a single-acting combination air-and-water pump, of slow speed and small capacity, which at the lower vacuums was sufficient but not at all economical. The Edwards pump—or as it should be called, the Bodmer pump improved by Edwards—was an improvement as a combination pump, and has helped to the attainment of better conditions; but it was not until the designers began to consider the condenser as a scientific machine, and to design it on rational lines, that definite improvement along broad lines appeared and persisted.

The modern condenser, whether built for high or low vacuum, consists of a shell of circular or rectangular section, with steam entrance near the top, and a large surface hot-well below. The ends of this shell are covered by the tube plates, and suitable supporting and baffle plates prevent the water of condensation from dripping on or flooding the tubes. Pipes outside the condenser shell have been used to carry this water to the hot-well. The tube sheet is so laid out that the proportion between length and diameter of the tubes, number of passes and velocity of the water may be such as to obtain the largest heat transference per unit of tube surface, and suitable passages are made among the tubes to insure the penetration of the steam to the surface of every tube. The circulating-water system is usually laid out on the counter-current or "contra-flow" plan, admitting the cold water to the lowest tubes, and taking off the heated water from the highest tubes in contact with the hottest steam, which insures the largest mean difference of temperature between water and vapor. Somewhere near the bottom of the condenser, in the coldest circulation, a nest of tubes is set aside as an air cooler and covered with a baffle to keep out water. Here the non-condensable vapors are taken off by a dry-air pump, or they may be mixed with the coldest portion of the water of condensation and removed with a combination pump of the Edwards or bucket type. The condensed water is removed from the hot-well by a centrifugal or direct-acting wet-vacuum pump.

The Two Stroke Converted Gas Engine for the Oil Regions

By George J. McFadden

A two-stroke-cycle "converted" gas engine consists of a gas-engine cylinder complete with piston, piston-rod, valves, hot tube and gas connections, attached and adjusted to the frame of a steam pumping or drilling engine, from which the steam cylinder, eccentric rods, straps, eccentrics, and pump have been removed. The original crank-shaft, connecting-rod fly-wheels and bearings of the steam engine are used. Engines of this type are sometimes fitted with a governor, but this is seldom done in oil-country practice as the engines always work under a load, and as soon as the well is pumped they are shut down. Engines used for drilling purposes are equipped with a reversible clutch on the belt pulley, and an arrangement for controlling the speed by hand. The speed control is so constructed that there is no chance of stopping the engine by pulling the throttle entirely shut, the gas by-pass being regulated so as to just run the engine even if the throttle is closed. The reversing gear and throttle are operated from the derrick floor.

The original method of pumping an oil lease was to install one steam engine at each well and have a central boiler station which would supply steam for a number of wells. When the lease was of any magnitude there would be anywhere from four to five boiler stations on it. On such a lease large quantities of gas were used, from which only about 50 per cent. of the available heat energy was turned into work on account of radiation from the steam lines, which were laid in boxes on the surface of the ground, and also on account of the leakage of steam through the engine valves, which were seldom set or fitted to give the best results. Many of these leases are now operated by means of the two-stroke-cycle converted gas engine. The saving to the oil producer can be appreciated when one considers that the gas is used directly by the engine with no waste. The supply of water needed is cut down to about 50 per cent. of that used in the boilers.

The converted two-stroke-cycle gas engine is adapted to oil-country work on account of its simplicity and the ease with which a steam-drilling or pumping engine may be converted into a gas engine. The old steam engine is "relieved" of its steam cylinder and accessories put in good shape as regards bearings and crank-shaft, then the gas cylinder is bolted to the old frame, and the engine is set up and tested. Hot-tube ignition is generally used on this type of engine although some builders

are using the make-and-break system. The engine in Figs. 1 and 2 was recently converted. While the principle of operation is the same as on other engines of this type, the construction shown is superior to that commonly used for taking the mixture into the chamber *D*. The usual construction of this part of a two-stroke engine generally contributes to the back-firing commonly manifested by this type.

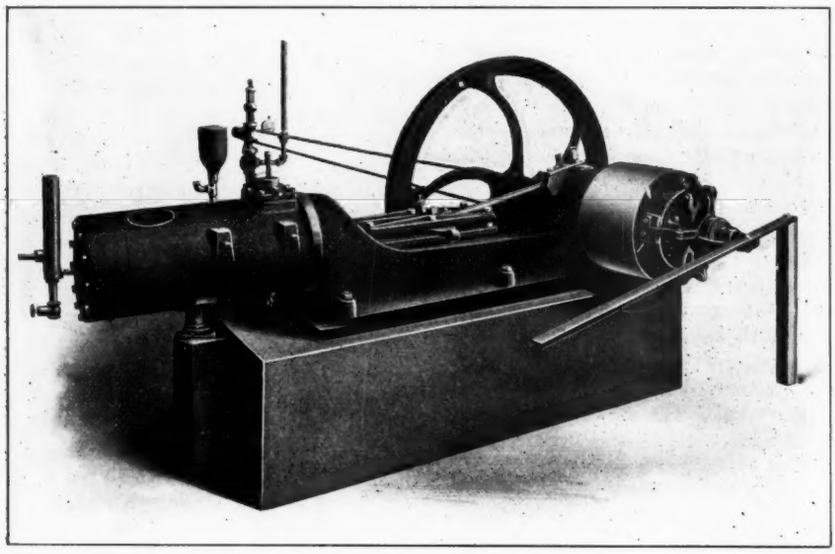


FIG. 1. TWO-STROKE-CYCLE CONVERTED GAS ENGINE

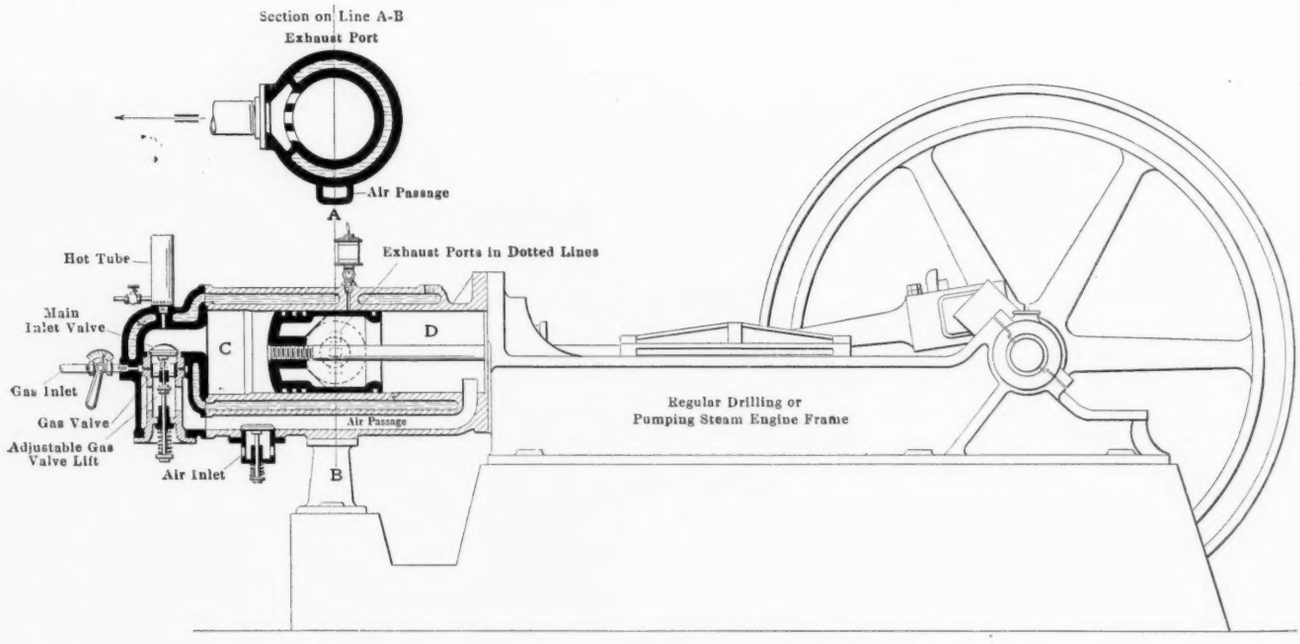


FIG. 2. SHOWING SECTIONAL VIEW OF CYLINDER, ETC.

The operation of the engine here shown is as follows: On the backward stroke of the piston air alone is taken into the inlet valve, filling the space *D*, and the mixture in the chamber *C* is compressed to about 60 or 70 pounds absolute and is ignited by the hot tube at the end of the backward stroke. The force of the explosion and the expanding gases impel the piston forward, and it forces the air in the chamber *D* through the main inlet valve into the compression space *C*. The opening of the main inlet valve also effects the opening of the gas valve, and the gas is swept along with the air into the compression space. By means of the adjustable gas-valve lift the gas valve can be opened somewhat later than the main inlet valve, thereby giving the air a chance to scavenge the cylinder before the admission of the mixture. At the end of the forward stroke the burnt gases are released through the exhaust ports at about 35 pounds pressure, the exhaust ports being uncovered by the piston. All parts of the cylinder wall and cylinder-head that come in contact with the burning gases are well water-jacketed on account of the double frequency of explosions in this type of engine. The speed of these engines varies from 150 to 200 revolutions per minute. The standard stroke and bore is 9x12 inches, as this is about the largest size cylinder that the steam-engine frames will stand without going to pieces. The gas cylinders are built, however, as small as 7 inches in diameter.

Something Novel in Generating Plants

Two very interesting generating plants have recently been built in the north of England, the novelty of which furnishes food for much thought on the possibilities for economies in the manufacture of electricity by proceeding along lines that have, up to the present, received no general attention.

One of these presents the unusual spectacle of a steam-driven generating plant without a boiler house. It is owned by an electricity company, but is built by arrangement on the property of a large pig-iron mill. This mill develops a large amount of steam for operating its own machinery, using cupola gases as fuel, and then turns over the exhaust steam to the lighting company for the operation of two low-pressure turbines aggregating 3000 kilowatts in total capacity.

The other plant, one of 4000 kilowatts, uses as fuel the waste gases from the ovens of a neighboring new-process coke-manufacturing company.—National Electric Light Association *Bulletin*.

The Reynolds Long Range Cut-off

The Essential Features of Design and Operation of This Valve-gear As Usually Employed on the Allis-Chalmers Engines of This Type

BY HUBERT E. COLLINS

To operating engineers in general the Reynolds long-range cut-off is not very well known. On the surface there appears to be nothing out of the ordinary in the valve-gear that would distinguish a Reynolds from any other Corliss engine, but upon closer inspection some essential features will be found so radically different that they will cause the uninitiated considerable trouble until the movement is understood, after which the valve-gear is simplicity itself. The long-range cut-off is designed to give a maximum cut-off for power, and the essential feature of the steam valves is that they have a negative lap or opening when in mid-position, the cut-off being made entirely by the governor through the knock-off cam.

In the first engine of this design built by Mr. Reynolds for the World's Fair at Chicago, an auxiliary eccentric operated levers on the governor in such a manner as to cause the knock-off block to follow the hook until cut-off occurred, but in all details the valve motion is apparently the same as on other engines. To come to a

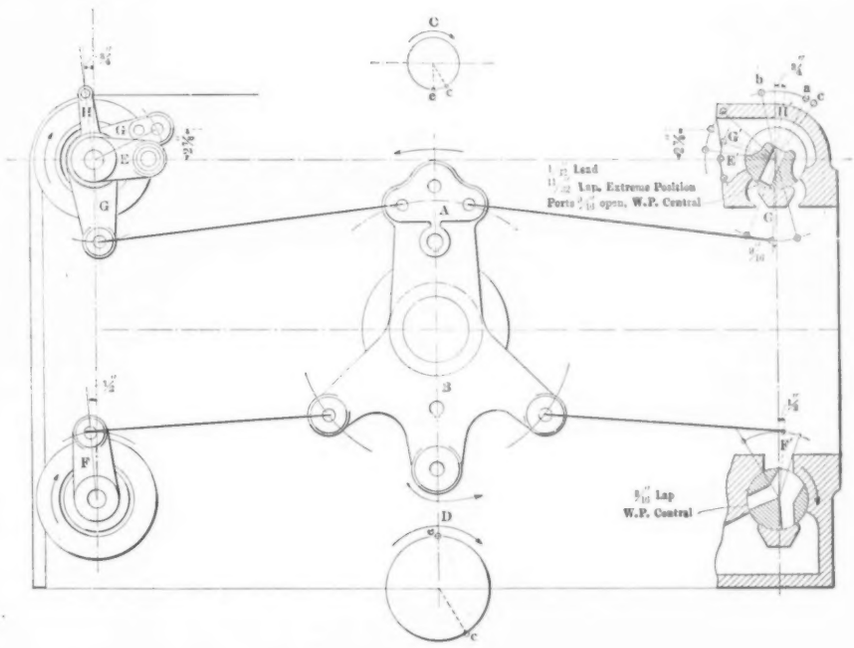


FIG. 2

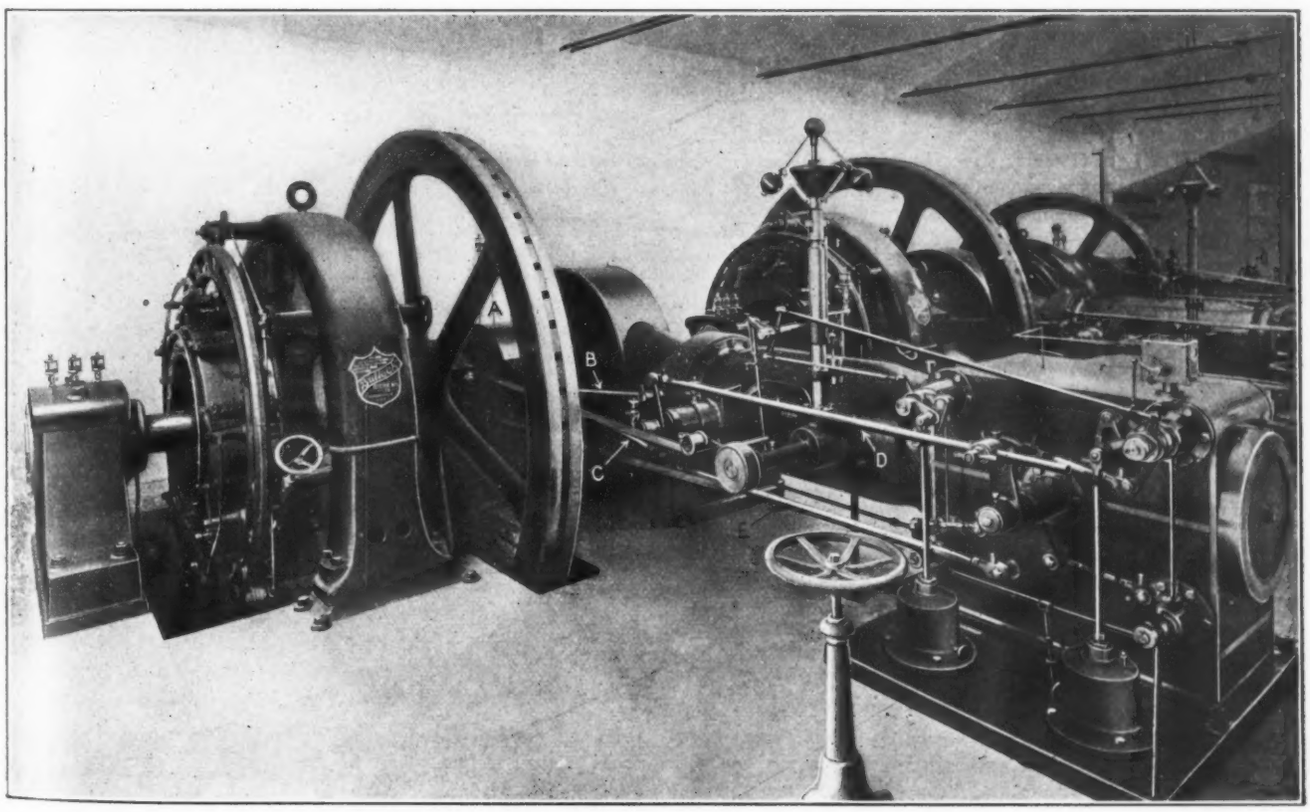


FIG. 1. VALVE-GEAR SIDE OF REYNOLDS LONG-RANGE CUT-OFF ENGINE

full understanding of the peculiar features in the design and operation, a careful study of the complete movement during a revolution of the crank is necessary.

Fig. 1 is a view of the valve-gear side

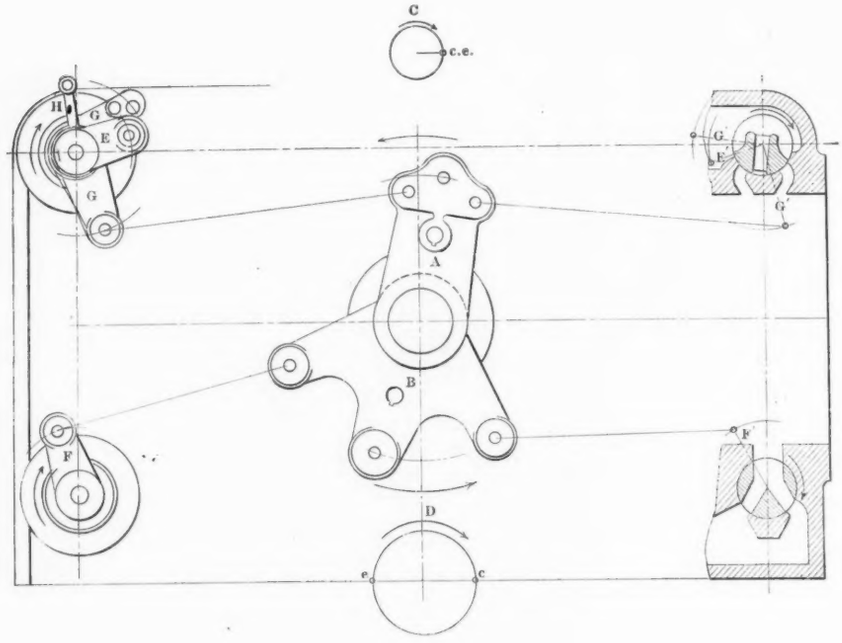


FIG. 3

of this type of engine. The eccentrics are in the case *A*, the steam eccentric-rod is indicated by *B*, and the exhaust by *C*, while the steam and exhaust rods are respectively at *D* and *E*. It will be noted that the motions from the eccentrics to the wrist-plates are direct. The steam and exhaust wrist-plates, valve-rods, etc., can be easily traced from Fig. 1.

To obtain the first impression of how the interior of the valves look, refer to Fig. 2, in which the steam and exhaust valves on one end of the cylinder are shown with the valve-gear removed and the valves and ports in cross-section, while on the other end the valve-cranks have been left in place and show their relative position to the valves at the opposite end. The steam and exhaust wrist-plates are shown at *A* and *B*, respectively, and above *A* is shown the travel circle *C* of the steam eccentric; below is the exhaust circle *D*. In these circles the crank position is at *c* and *e* is the eccentric position. The steam valve-crank is indicated by *E*, the exhaust valve-crank by *F*; *G* is the bell-crank and *H* the knock-off cam. On the other end of the cylinder where the valves and ports are in cross-section, the dotted lines *E'*, *F'*, *G'* and *H'* denote the center lines of the same parts on that end, and the arcs at the ends of these lines show the respective positions of the pin centers. From each end of these arcs the center lines show the positions of the pins when they reach their respective extremes of travel.

Steam Valves Open at Both Ends When Hooked Up

In Fig. 2 the wrist-plates and all connected parts are shown in their central positions, at which the exhaust valves are lapped, as is usual in practice, but the steam valves are open on both ends when they are hooked up. If hooked up and not released the steam valves would be open from the beginning of one stroke up to 75 per cent. of the return stroke, but when the knock-off cam-pin center is at *a*, the cut-off will be carried out to about seven-eighths or eleven-twelfths of the stroke, and the cut-off will occur just before the steam valve on the opposite end picks up for lead. When the knock-off cams are in the position represented by the lines *H* and *H'*, Fig. 2, the cut-off will occur at about three-eighths of the stroke, and when the knock-off pin center is at *b* the valves will remain lapped, being dropped before they can open. If the regulator is allowed to drop down so the knock-off cam-pin will reach the point *c*, the valves will not pick up and will remain lapped. This peculiarity must be thoroughly fixed in mind.

When an ordinary valve is at the center of its travel, it is lapped on the steam edges and full open to the port when at the extreme of its travel in one direction; at the other extreme of travel it is closed. With the engine under discussion the steam valves are lapped at the extreme throw of the eccentric in one direction, and full open at the other extreme, having minus lap when at the center of travel.

When the steam valve is lapped the proper amount, the dash-pot plunger is down at the bottom of its travel, and the cranks *E* and *E'* are at the lowest positions of their travels. The eccentric must come over to its extreme position in order that the valve may be picked up. Owing to the dash-pot and method of cut-off on a Corliss engine, this arrangement can be applied, but is not applicable to any other type of valve.

For the purpose of illustration let it be assumed that the steam valves pick up and do not cut off through the medium of the knock-off cam, and let us follow the action of one valve through one revolution of the crank. In Fig. 3 the valve-cranks are in their extreme po-

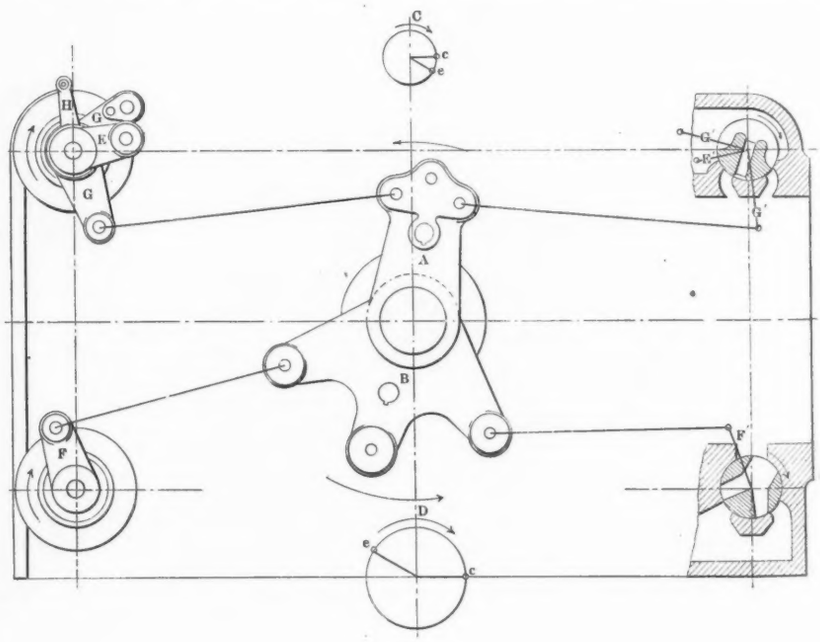


FIG. 4

sitions, and the eccentrics likewise, with everything ready to start in the direction of the arrows. On the crank end the steam valve is lapped and the exhaust valve is open, while reverse conditions exist on the head end. On all other types of valve-gear the eccentrics would be advanced 90 degrees when the valves are lapped, but on this engine the steam valve is lapped when the eccentric is on its extreme position. The exhaust valves are the same as on any other double-eccentric Corliss engine.

In order to get the positions of the eccentrics in relation to the crank, we will advance the steam eccentric, until the proper amount of lead is obtained, and the exhaust eccentric until the proper amount of closure is reached. From Fig. 4 it will be seen that the steam eccentric is only some 30 degrees in advance of the crank, or only enough to overcome the lap and lead, and the exhaust eccentric follows the crank. Assuming that the eccentrics have been made fast to the shaft in these relative positions, we will now move the crank around in the direction of the arrows until the position shown in Fig. 2 is reached, where it will be noted that the crank has advanced on the first half of its revolution some 60 degrees or thereabouts.

In Fig. 5 the eccentrics are shown in their extreme positions opposite to that at which they started, and the steam valve is shown wide open with the exhaust valve closed as far as it will go. The next positions indicated in Fig. 6 show the steam valve closed when the crank has reached approximately 75 per cent. of its return stroke. This would, of course, prevent the practical operation of the engine unless the regulator, through the knock-off cam, does its work of cutting off at the proper moment.

It is well to bear in mind that when the steam valve carries out to the latest point of cut-off, it is released before the other steam valve picks up to open, and that while the release of the steam valve varies, the pick-up does not. It is thus impossible for both steam valves to be open at the same time although they may appear to be arranged to the contrary. On an ordinary Corliss engine the valves will hook up without releasing when the regulator is at its lowest working position, but with this type the valves are released alternately every stroke, no matter how low the regulator, unless it is in the safety position, when the valves would not pick up at all.

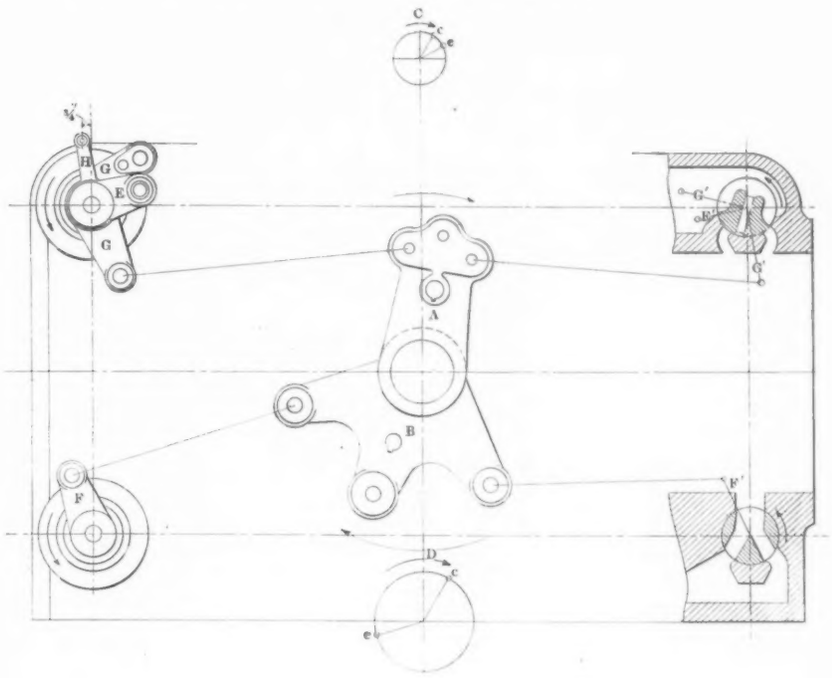


FIG. 6

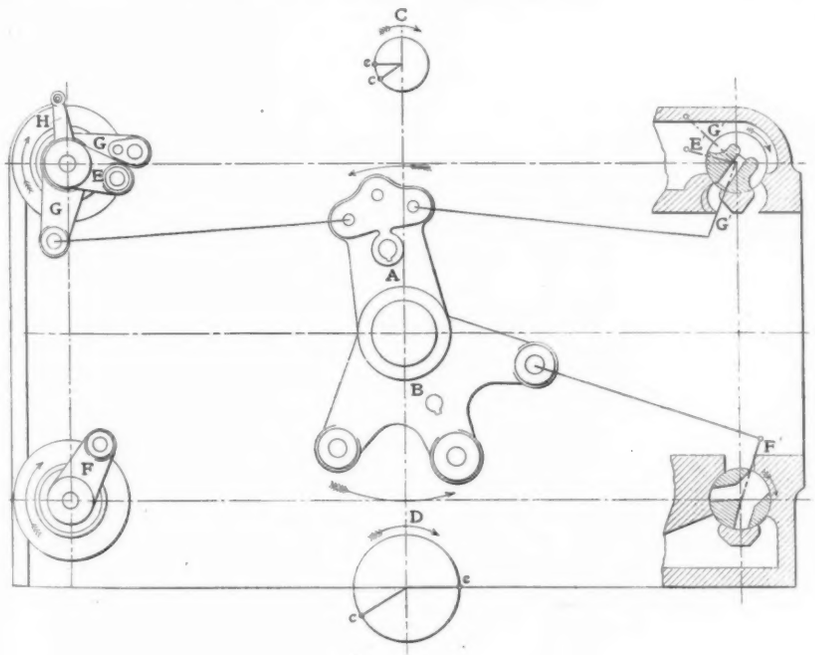


FIG. 5

Setting the Valves

Bearing these points in mind we may proceed to set the valves. The amounts of lap and lead and the positions of the cranks from the center lines given herewith are for engine cylinders of 36-, 42-, 48-, and 60-inch stroke.

First set the wrist-plates central and clamp them in place; then adjust the lengths of the rods so that the steam valves are open 11/32 inch, as shown in Fig. 2, and the exhaust valves are lapped 3/16 inch. If the rod lengths are right the center lines of the cranks *E* and *E'* will coincide, the pins of the cranks *F* and *F'* will be one-half inch from the center line, as shown, and the pins on each end of the bell-cranks *G* and *G'* will be 2⅞ inches and 9/16 inch from the center lines. When the valves have been set with the wrist-plates central, release the wrist-plates and roll the eccentrics around the shaft to test them and the reach-rods, and see that they are of the right length to make the wrist-plate travel equally each side of the center line.

Then place the crank on center and pull the steam eccentric around enough to give 1/32-inch lead, and make it fast. Next move the engine around in its direction of travel to about 95 degrees of its stroke and move the exhaust eccentric around until the exhaust valve on the same end is just opening or releasing. Make the exhaust eccentric fast and move the engine around its full revolution and check off the valves on

the other end and the exhaust closure. Then set the regulator up to its central position and adjust the lengths of the rods from the lever to the knock-off cams, so that the pins of the cams *H* and *H'* will set ¾ inch off the center line, as in Fig. 2. Let the regulator down and hook up the wrist-plates; then pull the engine around to make sure that the steam valves are released on each stroke alternately at not later than eleven-twelfths of the stroke, and always before the other valve picks up.

Catechism of Electricity

722. *When two or more compound dynamos are used together for giving* 110-*volt service, how are they generally connected?*

To a three-wire system, as illustrated in Fig. 246. Four compound dynamos are shown, two being connected on each side of the neutral wire. As many machines as desirable may thus be connected, taking care that all of those on each side of the neutral are properly connected in multiple. In the sketch, *j* is the neutral bus-bar, *i* the negative and *l* the positive bus-bar. The dynamos *r* and *s* are connected on the negative side, and the dynamos *t* and *u* on the positive side of the system. In the connections for the dynamos *r* and *s*, the wires *a* and *d* run to the negative bus-bar *i*, and the positive wires *b* and *e* run to the neutral bus-bar *j*, to which are also connected the negative wires of the dynamos *t* and *u*. The equalizer wires of dynamos *r* and *s* extend to a separate bus-bar *k*, and in order that they may be simultaneously connected with and disconnected from the mains they are led through the same switches, *g* and *h*. On this account the switches *g* and *h* are provided each with three blades, the middle one controlling the equalizer connection. The jaws receiving the middle blade are a fraction longer than the others, so that when the switch is thrown in, the equalizing circuit will be closed a trifle sooner than the main circuit. This is to avoid the danger of having one machine feed into another one.

The equalizing wires of the dynamos *t* and *u* are connected through the bus-bar *m* and the positive wires are connected to the bus-bar *l*. The current for the line passes out on the positive wire from the dynamos *t* and *u*, and after passing through the outside circuit returns through the bus-bar *i* to the negative terminals of the dynamos *r* and *s*. Any one of the dynamos may be provided with a double-throw switch by means of which it may be connected to either the positive or the negative side of the system. The reader should be careful not to confound the equalizing bus-bars with the others.

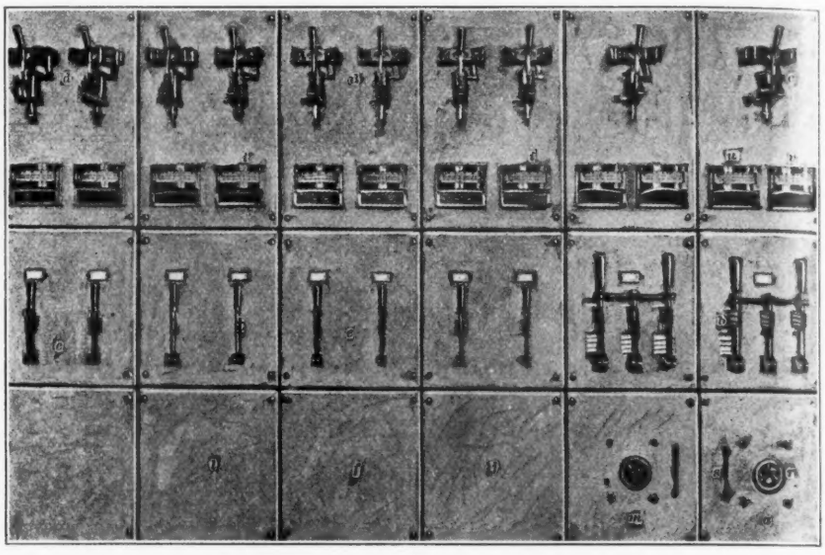


FIG. 247. SIX-PANEL SWITCHBOARD EQUIPPED FOR OPERATING TWO COMPOUND-WOUND DYNAMOS IN MULTIPLE, SUPPLYING FEEDER CIRCUITS

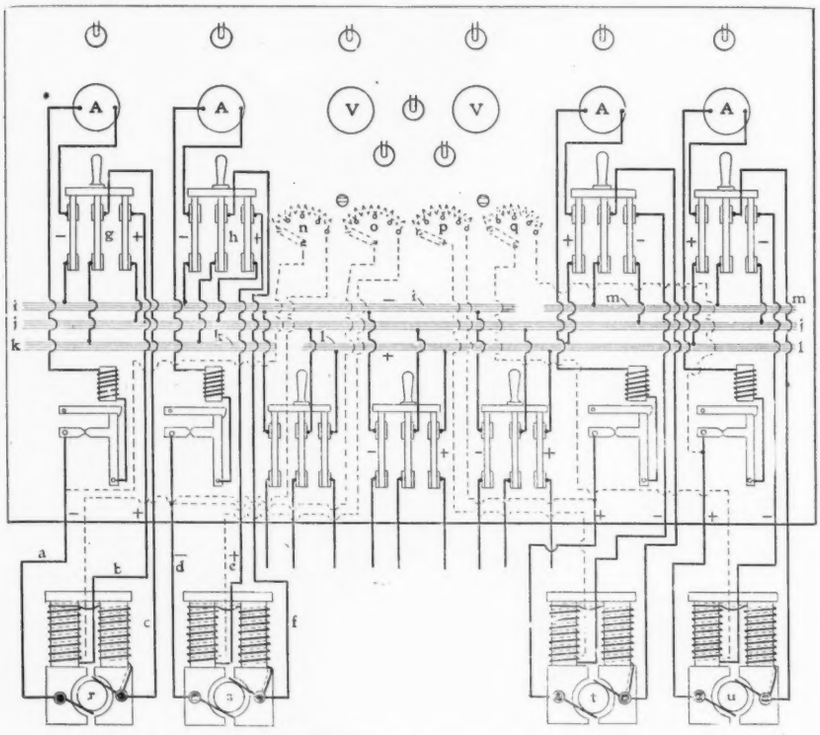


FIG. 246. WIRING OF SWITCHBOARD FOR OPERATING FOUR COMPOUND-WOUND DYNAMOS ON A THREE-WIRE SYSTEM

The field rheostats *n*, *o*, *p* and *q* are located behind the center of the switchboard, where there is the most room for them; their connections are indicated by the dotted lines. Only two voltmeters are provided, one being connected between the neutral and the positive bus-bars and the other between the neutral and the negative bus-bars.

723. *When two or more compound-wound dynamos are operated together for* 550-*volt service, how are they connected?*

In parallel between two main bus-bars.

724. *Show a switchboard equipped for this kind of work.*

Figs. 247 and 248 show respectively front and rear views of such a switchboard equipped for two dynamos; the controlling and indicating apparatus for the dynamos is mounted on separate panels, *m* and *a*, at the right-hand end of the board. On the panel *a* are the field rheostat *r* and the field switch *s* of generator No. 2. The corresponding apparatus of generator No. 1 is shown on the panel *m*. The three-pole main switch of generator No. 2 is shown at *b*, the middle blade being for the equalizer connection. The voltmeter and ammeter for this dynamo

are shown at *u* and *v*, respectively, and the circuit-breaker is at *c*.

To the left of the generator panels *m* and *a* are the feeder panels *n*, *l*, *f* and *j*, on which are mounted the instruments of eight feeder circuits. The feeder circuits pass from a bus-bar, connected to the main switches on the generator panels *m* and *a*, through single-pole switches at *e*, *e*, etc., ammeters *i*, *i*, etc., and circuit-breakers *d*, *d*, etc., in the order named. The bus-bar and switch connections are shown in Fig. 248.

The ammeters show how much current each feeder is carrying, and if the current on any one feeder becomes excessive, the difficulty can be looked up and remedied without interfering with the rest of the system. If a short-circuit should develop on any one line, the circuit-breaker connected in that line only will open, leaving the other circuits undisturbed.

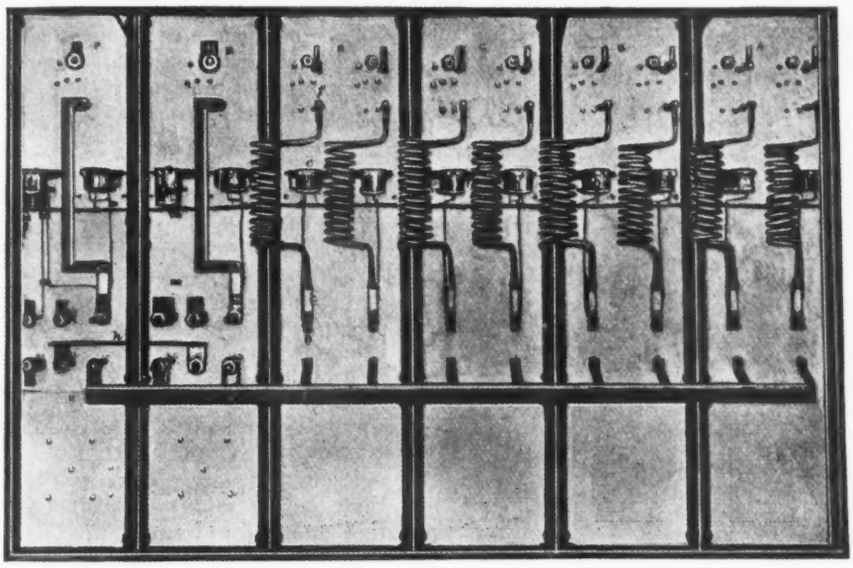


FIG. 248. REAR VIEW OF THE SWITCHBOARD SHOWN IN FIG. 247

725. *What is the meaning of the letters painted on each division or section of the switchboard near the top of the panels?*

These letters are used for identifying the different circuits. For the purpose of tracing the connections, the different parts of one circuit in division *D* have been designated by letters. Connection with one terminal of the machine is first made at the bottom to the bus-bar and the open space *b* is accounted for by the switch on the front of the board. At *c* is an ammeter shunt, the ammeters used on the board being of the shunted type. From *c* the current passes through coil *d*, and thence to the circuit-breaker at *f*. From this, the circuit continues through the feed wire which is connected to the upper terminal of the circuit-breaker.

The article on "An Easily Remembered Method of Converting Thermometer Scales," on page 33 of the July 7 number, was contributed by David J. Block, not "David J. Clark" as printed.

Economical Steam Production

By Carl S. Dow

As expressed by W. L. Abbott, chief operating engineer for the Chicago Edison Company, "the greatest possibilities for saving or wasting about a steam plant are undoubtedly in the coal pile, but as it is a dirty proposition and many of its features not well understood, the subject does not receive the consideration to which it is entitled. The average ambitious engineer will spend much time and care on his engine to be sure that the indicator cards are perfectly symmetrical, that the points of cut-off are equal, that the release is in time and that the compression rises to meet the admission in a smooth rounded curve. This is proper and commendable, yet the same time spent in studying the conditions of combustion in his furnace might show him a way to make a saving in fuel four-fold greater than is possible in the final refinement of the indicator cards."

While Mr. Abbott was right when he said that the greatest possibilities for saving could be found in the coal pile, he doubtless had in mind the entire apparatus for the generation of steam. The impression he wished to convey was that less effort is required to effect a saving in the generation of steam than in the use of steam.

Many engineers, especially those of little financial experience, pride themselves upon the economy of their engine and complacently state that it is giving the maximum power per pound of steam, and therefore the plant cannot be made more economical without getting a better engine. But is this true? In most cases, no, because the steam supplied to the engine can usually be generated at less cost. Slight savings can be had by a careful consideration of stoking, by a wise selection of fuel, or by heating the feed-water with waste steam; but the fuel economizer, by means of which the feed-water is heated by the waste gases, is usually productive of so great a saving as to pay handsomely on the investment.

Financial Side of Economizers

The installation of an economizer is primarily a financial question, a question that concerns the designing engineer, proprietor, or treasurer more than the operating engineer, for to a man who designs the plant or pays the bills, a device or apparatus is economical only if it shows a saving when all legitimate expenses are charged to it. The extent to which financial calculations enter into engineering both in new work and alterations is seldom realized by the operating engineer.

The following example, which gives actual figures, will show to what extent a company will go in the matter of alterations when once convinced that the resulting saving will be worth while: In a certain industrial plant twelve 250-horse-power water-tube boilers were installed, each having a steel stack. Upon deciding to use a fuel economizer, extensive changes were necessary. Since there was no room for the economizer in the boiler house, and the engine house was very near the boiler house on one side and the railroad track on the other, it was necessary to put the economizer on heavy structural steelwork on the roof of the engine house. It was further necessary to replace the twelve individual stacks and flues by one large chimney, 250 feet high, and a large main steel-plate flue, so that all the waste gas could be conducted through the economizer to the chimney. These alterations, including steelwork and foundations, were so expensive that one could hardly see how it would pay, especially as the cost of the economizer and accessories was practically $15,000. The builders of the economizer guaranteed a saving of 11 per cent. in fuel, which was almost enough to pay for the economizer and alterations in two years. Let us see how this could be. Assuming certain conditions which are sufficiently accurate to show the method, the calculation may be made as follows:

There are 12 boilers in the battery; probably 10 of these are in operation 24 hours per day. Then the boiler horsepower would be 2500 and, as 3½ pounds of coal are burned per boiler horsepower, 8750 pounds or 4⅜ tons are consumed per hour, and 105 tons per day. The coal cost would be $5 per ton at the boilers, or $525 per day, or $157,500

per year of 300 days. As 11 per cent. is to be saved, the yearly guaranteed saving would be

$$0.11 \times 157{,}500 = \$17{,}325.$$

The cost of the alterations and that of the fuel economizer was about $30,000, but this does not represent the entire expense. There is interest on the money expended, and allowance should be made for depreciation, or in other words a sinking fund should be established. Again the plant is more valuable, doubtless causing additional taxes. The steam necessary to operate the scraper mechanism and the cost of repairs must also be included. Evidently the interest should be reckoned on the $30,000, but the depreciation should be based on the cost of the economizer only, or $15,000. Assuming that the economizer will last 20 years, the depreciation would be 5 per cent. per annum. The taxes, repairs and operating expenses also should be based on the cost of the economizer. The various items of expense are as follows:

Interest ..... 5 per cent. of	$30,000 =	$1500
Depreciation, 5 per cent. of	15,000	750
Repairs ..... 1 per cent. of	15,000	150
Operation ... 1 per cent. of	15,000	150
Taxes ..... $15 per thousand on	15,000	225
		$2775

For two years, this would be $5550, which added to $30,000 would make the total cost $35,550; but in two years the amount saved would be $34,650. In other words, the savings for two years would pay for practically the entire outlay.

The percentage return on money invested is a good indication of the value of an investment. In this case there is invested $30,000, but what is the percentage? The gross saving per year is $17,325 from which must be deducted the expenses of taxes, interest, depreciation, repairs, etc., or $2775. Then the net saving is

$$\$17{,}325 - \$2775 = \$14{,}550$$

and the percentage

$$\frac{14{,}500}{30{,}000} = 48.5.$$

This is an excellent investment, especially as it pays this interest on $15,000, an expense which would not appear in a new plant.

Calculation of Saving

It has been stated that the guaranteed saving in fuel was 11 per cent. but was this percentage calculated or merely an estimate made by the manufacturers? It was an estimate made after calculation, which is, of course, theoretical. There are several ways of making the calculation; for instance, the temperature and volume of gas being known, a chemical analysis will give the specific heat per pound. The theoretical amount of heat that can be transferred from the gases to the water can be then determined; but to make the results of practical value, certain coefficients must be applied, coefficients found from experiments only, and as these experiments are expensive, the resulting coefficients are carefully retained by the builders who make the tests. This heat-unit method is particularly valuable for work other than steam plants, such as in connection with furnaces in steel plants, smelting plants, etc., also for a check on other computation.

Companies making fuel economizers also use curves and tables compiled from tests of actual installation. For instance, if 5 square feet of economizer surface is used per boiler horse-power and the temperature drop of the hot gases is 200 degrees Fahrenheit, the experienced engineer-salesman can tell how many degrees a given amount of water will be raised.

The most common way of determining the saving effected by heating the feed-water, and the one generally employed to get a theoretical figure is the formula derived from a consideration of temperatures and heat units:

$$\textit{Gain in per cent.} = \frac{100\,(T - t)}{H - t},$$

in which

T = Heat units in one pound of water above zero after heating,

t = Heat units in one pound of water above zero before heating,

H = Heat units above zero in one pound of steam at boiler pressure.

These quantities are readily found from the tables of the properties of saturated steam.

In the case of the power plant previously considered, the water enters the economizer at 200 degrees, and the extent of the economizer surface is sufficient to heat the feed to 350 degrees. The boiler pressure is 150 pounds gage.

Consulting the steam table we get:

$$\textit{Gain, per cent.} = \frac{100\,(354 - 200)}{1225 - 200} = 15.$$

Since the calculated gain by using the fuel economizer was practically 15 per cent., why did the builders guarantee only 11 per cent? This very natural question may be answered about as follows: The computation is, of course, theoretical and as operating conditions often prevent a realization of theoretical results, any manufacturer must be safe in guarantees. Again, in calculating the saving it was assumed that 10 boilers were in operation 24 hours per day, while in actual practice all these might not be worked up to rated capacity, thus reducing the amount of fuel used, and it is upon this that the saving is based. The 11 per cent. represents a reasonable saving and one that shows an excellent investment. In fact tests made on this particular plant have shown the saving to exceed 12 per cent.

Parallel Operation of Alternating Current Generators

By H. R. Mason

Alternating-current generators are comparatively free from the contingencies to which direct-current machines are liable and they do not have as many possibilities of complication in handling them. They are seldom equipped with automatic circuit-breakers, as the magnetic reaction of the armature places a limit on the amount of self-generated current that can possibly flow, and this is well within the carrying capacity of the conductors. The same reaction operates to reduce the voltage on a short-circuit to a point. An important point which must be considered which makes it impossible to maintain the destructive arc produced by direct-current when operating alternating current generators in parallel short-circuit if the conductors are spaced more than an inch or two apart is this absence of safety devices; in case of a short-circuit or ground in an armature or switchboard the operator should open the main switches without delay, as the abnormal current from the generators may have very destructive effects notwithstanding the armature reaction.

In paralleling alternators the permissible differences in voltage and phase vary so greatly as between individual installations that it is scarcely practical to set any definite limit. The voltages may have a much greater difference than in the case of direct-current generators without causing corresponding disturbances, as much as 10 per cent. difference causing comparatively little trouble in most cases; the amount of phase difference that is allowable depends more or less upon the frequency and the character of the load. A difference in phase of 5 degrees or over will result in an undesirable mechanical shock to the generators, especially if the generator to be cut in is ahead of the corresponding phase of the bus-bar current, but if the generators are running at approximately synchronous speed no harm is likely to result. The operators should take pains, however, to have the voltages equal and to close the circuit at the precise instant when the generators are "in step;" neglect of the former affects the power factor unfavorably, and persistent repetition of carelessness in the latter may ultimately cause damage to the generator by loosening the coils or the laminations.

If the load consists principally of lights and induction motors the effects of inaccuracy in cutting in generators will be almost imperceptible; but if rotary converters are supplied the effects upon them will be much more severe than those upon

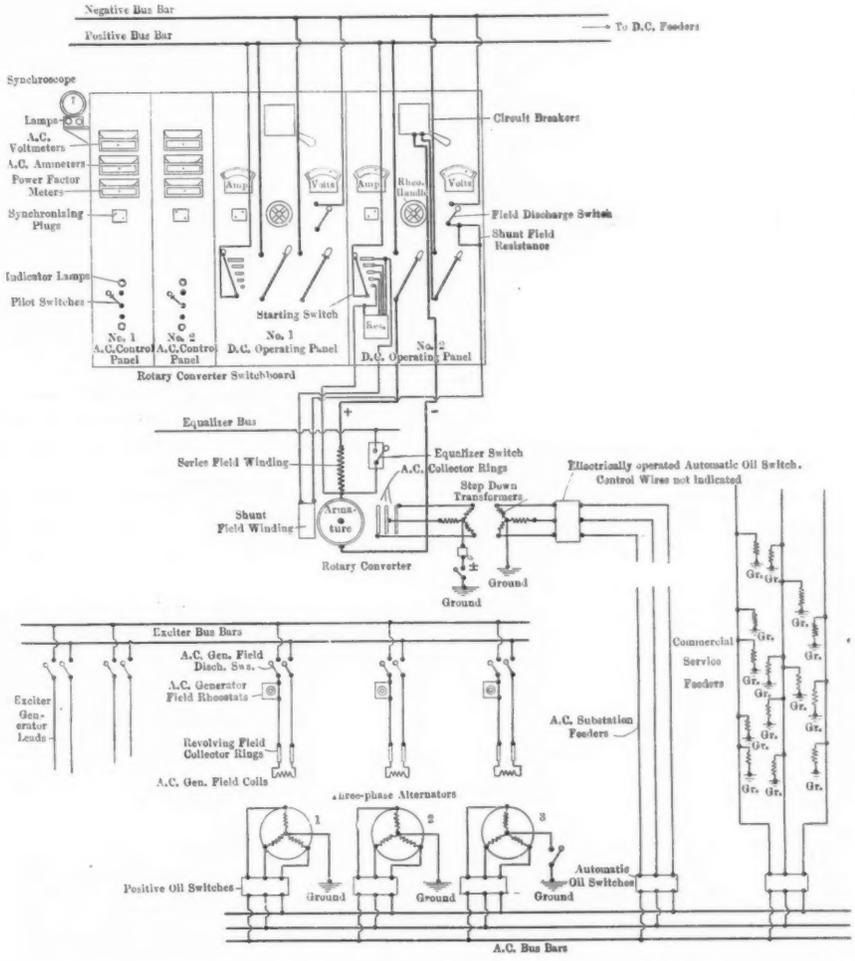
the generators, and as a rule the higher the frequency the more sensitive are the converters, though these characteristics depend much upon the design and relative capacities of the generators and converters.

A Frequent Source of Trouble

A source of trouble frequently encountered in cutting in alternating-current generators and converters in parallel is the tendency of oil switches to become erratic in closing. Manually operated switches occasionally give trouble by the mechanism becoming loose and causing imperfect contact to be made, or sometimes making no contact at all on certain legs. Electrically operated switches closed by a motor or solenoid in a secondary circuit controlled by a pilot switch have additional troublesome points, such as imperfect contacts and loose connections in the secondary circuit. Motor-operated switches usually require an appreciable time to close the main contacts after the pilot switch has been closed, and unless the operator allows for this the phase relations of the machine to the bus-bars may change enough during that time to cause trouble. Switches actuated by solenoids sometimes lag slightly, but are usually quicker than the motor-operated type if the solenoid is sufficiently powerful to start the plunger from rest. It often happens that insulating compound from the cables drips on the oil switches and gums the moving parts together so tightly that the motor or solenoid is unable to break them loose.

It will sometimes be found that when two or more alternators of slightly different characteristics are operated in parallel with grounded star connections there will be excessive cross-currents when the generators are grounded, necessitating a switch in the ground connection of one, as in No. 3 in the diagram; this switch must be left open when the generator is in parallel with others and closed when it is running alone. This, although absolutely necessary in certain cases, is rather unusual and it is an exceedingly undesirable arrangement. If the switch is left closed during parallel operation the attendant is certain to notice the excessive readings of the ammeter due to the cross-currents and thereby discover the fact. But if forgotten and left open when the generator is to run alone on an unbalanced load it may do a great deal of damage by forcing the current from the more heavily-loaded legs of the system through the transformers to the more lightly loaded leg, instead of balancing through the central connection of the star, and the situation could scarcely be detected at the switchboard until the damage was done.

In many stations care must be observed, in changing generators or starting additional units, that the exciter is not overloaded by the additional field current required. The exciter generators are also frequently installed without any safety devices to protect against overload, so it is possible to damage them seriously if too heavily taxed, and one of the most annoying accidents possible to an alternating-current generating station is to suffer a sudden failure of the exciter-current supply, either by an exciter generator burning out or by safety devices operating and cutting off the field current from a number of heavily loaded alternators. The accompanying diagram shows the essential wiring of an alternating-current generating station.



COMPLETE STATION DIAGRAM FOR THREE-PHASE GENERATORS AND ROTARY CONVERTERS

Boiler Headers and Connections

By H. J. Ott

The design of a boiler header and the connections between it and the boilers appears to be a simple problem, but in nearly every case there are difficulties to be encountered in the lack of headroom, in avoiding the breeching, in providing for expansion and kindred other obstructions requiring considerable ingenuity to solve. If it was only a case of uniting all boiler outlets into a common pipe or header without regard to the strains of expansion and ease of fitting the piping together, the difficulties would be few.

Today the boiler plant of average size consists of a battery of two to four boilers, each ranging in size from 125 to 150 horse-power for horizontal return-tubulars and 20 to 300 horse-power for water-tube boilers. The steam pressure varies from 100 to 175 pounds in the different installations, and it is with these averages that this article deals.

Size and Location of Header

The header itself should not only be a main for uniting the boilers, but should also act as a receiver-reservoir to counteract the effects of any momentarily heavy demand for steam which would otherwise tend to lift the water out of the boilers. A good rule for determining the size of a header is to make it equivalent in sectional area to the sum of the areas of the boiler outlets. Take for example a battery of four 72-inch by 18-foot horizontal tubular boilers each having 6-inch outlets. The size of the header should be $\sqrt{4 \times 6^2} = 12$ inches in diameter. The header should be made

the same diameter thoroughout its length to give it the greatest storage capacity possible, and the supply to the largest engine or steam user should be taken from as near the middle of the header as possible.

The location of the header must be determined by local conditions and by the relative positions of the boilers to the engine room, but the header should be so located that all valves, joints and connections are easily accessible, and so that the valves can be conveniently operated from a fixed platform or from the top of the boilers. It should not be necessary to use a movable ladder to control any steam valve on the header, as the chances are that the ladder would not be in its place in time of emergency or accident. Locating the header in front of the boilers over the firing space should be avoided if possible, as any leakage would be liable to discomfort the firemen. A good location is along the top of the boilers near the rear, the header being supported by brick piers built upon the boiler-setting walls, as shown in Fig. 1. A location preferred by many is along the wall of the boiler room at the rear of boilers, Fig. 2, the header being suported upon brackets attached to the wall. This is a good location especially where there is a lack of headroom over the boilers. Where the engine room adjoins the boiler room to the rear of the boilers, a good place for the header is along the engine-room side of the wall. This location is especially desirable on account of the better light and greater accessibility afforded. Where there are but two boilers in the plant and the engine room is to the side of the boilers, the arrangement shown in Fig. 3 will be found very satisfactory. It is not recommended, however, for more than two boilers on account of the great differences in the lengths of the boiler connections.

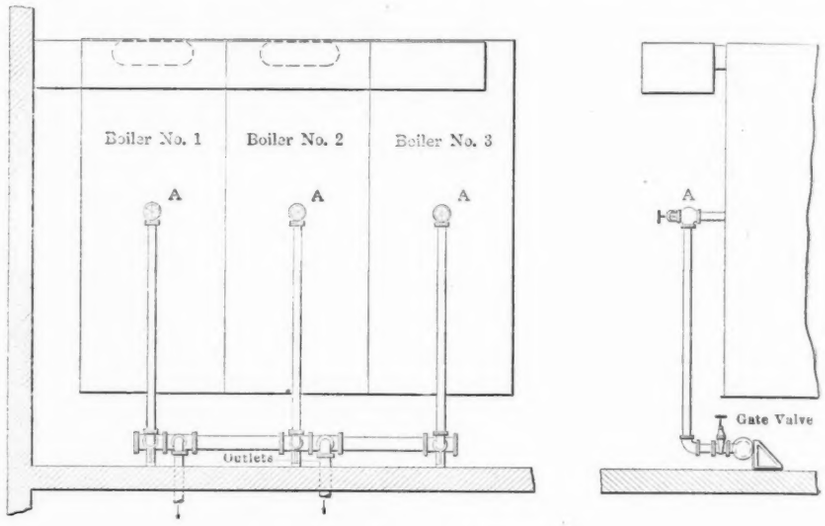


FIG. 2. BRACKET SUPPORT FOR HEADER

Drainage of Header

All boiler connections should enter the the header at the top and the outlets should also be taken from the top to insure that any water in the header will not be carried over to engine, but will be drained off at the proper place. It is not necessary to pitch the header for draining, provided that the drain connection is made close to the point where the heaviest draft of steam is taken. If the header is level, the movement of the steam toward the heaviest outlet will naturally cause the water in the bottom of the header to flow in the same direction. A good arrangement for draining a header is to use a cross at the heaviest outlet, with the outlet connection taken from the top opening and the lower opening fitted with a blind flange tapped for drainage, but the use of a good high-pressure trap attached to the drain opening of the header and discharging into a return tank, hot-well or open heater is in all probability the most reliable method.

Fig. 4 is an enlargement upon this idea. A drip pocket is formed by the

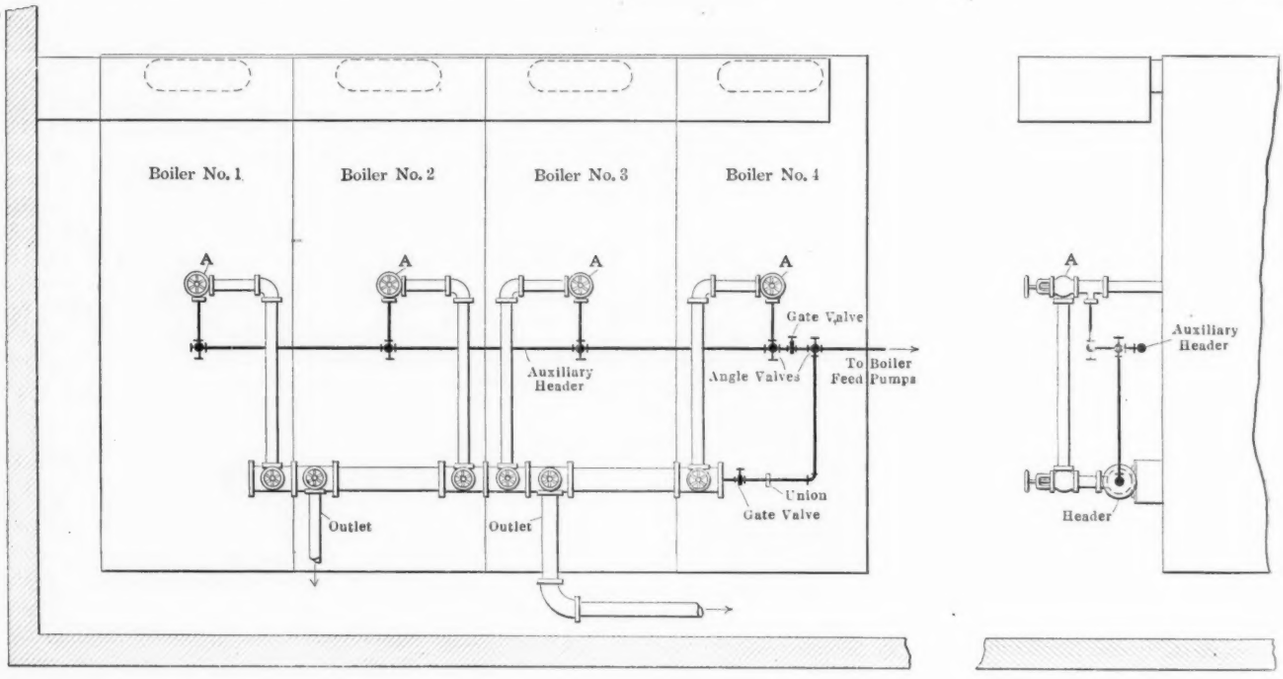


FIG. 1. HEADER SUPPORTED FROM BOILER SETTING

use of a piece of pipe of the diameter of the outlet above, or even larger if possible, and about 2 or 3 feet long, the bottom being fitted with a blind flange. This will serve as an emergency pocket to receive any unusually large slugs of water that may enter the header and momentarily tax the capacity of the trap. A gage glass is attached to show if header is being properly drained. Use a ¾-inch trap for a two-boiler header, and 1-inch and 1¼-inch traps for three- and four-boiler headers respectively.

Fig. 1 also shows an auxiliary header which can be included in the arrangements shown in Figs. 2 and 3. These auxiliary headers are often installed to insure a steam supply to the boiler feed-pumps in case the main header is shut off for repairs.

Flange fittings are strongly recommended for the header and its connections. The ease of assembling the fittings and tightening up any leaky joint places the flange at a great advantage over screwed fittings. Use metallic gaskets between all joints, and long-radius elbows may be used where it is not desired to have the short turn of the regular elbows. Nothing difficult should arise in the construction of the header save only the care in the proper placing of the inlet and outlet tees. If the header is made up of flange fittings, the outlet tee or tees should adjoin an inlet tee, which would reduce the number of flange nipples and joints.

Connection from Boiler to Header

More care, however, is required in the design of the connection from the boiler

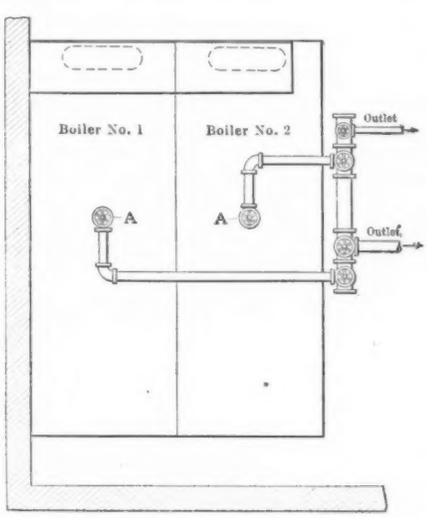


FIG. 3. A TWO-BOILER ARRANGEMENT

to the header. This connection must be as short and direct as possible, but should be flexible enough to take up the movement due to expansion in the boiler setting or header. It should also be flexible enough to be easily connected up and without undue strain for slight errors that may be made in measurements or cutting. Oftentimes the pipe is cut many miles distant from the installation, and it is especially desirable in these cases to not have the connections so rigid that delay and trouble would ensue should a slight variation be found. This is especially true when three or more boilers are connected. It is good practice to install not less than 12 feet of 6-inch pipe, 10 feet of 5-inch pipe and 8 feet of 4-inch pipe, exclusive of fittings, on a connection between the boiler and the header.

Valves

The question of valves is next in order. The day of the single valve in each boiler connection is passing. Many cities by ordinance now require two valves in each connection and many engineers know only too well what it means to crawl into a boiler with a leaky valve on top of them. This condition can be eliminated by the use of two valves. Globe valves should be avoided on account of the turns in the steam path, gate and angle valves being preferable. One of the neatest and most efficient arrangements is to use two angle valves, one on top of the header and the other on top of the boiler, as shown in Fig. 1. Another good arrangement, shown in Fig. 2, is to use an angle valve over the boiler and a gate valve near the header.

Automatic stop- and check-valves are daily finding favor and are coming into general use. These valves which are adaptations of the ordinary check-valve, are generally made in the angle type to set over the boiler outlet. The disk falls to its seat when the flow of steam reverses, so that if a tube should blow out the automatic stop and check or non-return valve would close because of the unblanced pressure, thereby isolating the disabled boiler from the others. The advantages of such an arrangement are fully apparent. The check disk in these valves is not attached to the valve-stem, but the valve can be used as an ordinary stop-valve by screwing the stem down until it holds the disk securely on its seat. It is impossible to open this type of valve when the boiler is out of commission, and this in itself is a safety item to be considered by those who have to enter boilers for cleaning or repairs. The non-return valve will also close if the boiler becomes sluggish in generating steam and will not open until the pressure equals that in the header. The valve should be equipped with an outside lever or indicating device which will clearly show whether it is open or closed.

There are a few types of non-return valve which have an added feature of closing if the velocity should increase in the regular direction beyond the normal rate, which might easily be caused by the bursting of a pipe or joint in the piping system. The location of the automatic stop and check-valves should be as near as possible to the boiler outlets. In Figs. 1, 2 and 3 they would

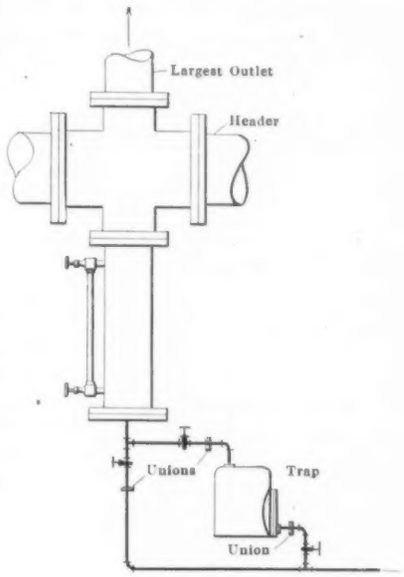


FIG. 4. METHOD OF DRAINING HEADER

take the place of the angle valves marked *A*. Where the ordinary angle or gate valves are used, they should preferably have rising stems to readily indicate whether the valve is open or closed.

The Watt Memorial

The James Watt memorial building, at Greenock, Scotland, is of red sandstone, with a base of rough-faced granite. It comprises two large class rooms, each 40 feet by 24 feet, which are to be utilized for the teaching of navigation and marine engineering. In connection with these departments, a large number of donations have already been made, including models of ships and engines, and there is also a fully equipped library. The memorial has been erected on the site of Watt's birthplace, and the bronze statue is placed in a niche at the corner of the building. It bears the following inscription: "James Watt. Born, 1736; died, 1819. This memorial building is erected on the site of his birthplace."

On page 95 of the July 21 number, in the description of the Carney Coal Company's plant, it was made to appear that the Erie City engines in that plant were built by the Goodman Manufacturing Company. They were built by the Erie City Iron Works, of Erie, Penn.

A soft carbon brush that sparks may sometimes be cured by raising it to a red heat and then plunging into a bath of ordinary lubricating oil.

Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

Effects of Superheating Moist Steam

The points in regard to superheating moist steam, brought out by J. C. William Greth in the July 7 number, are highly instructive, particularly his calculation of the amount of impurities carried over to the superheater and engine or turbine by wet steam from a boiler using average feed water. A point which is not fully explained, however, is the effect of moisture in destroying superheat. In a superheater operating with dry steam, we have conditions something like the following: A temperature of from 1500 to 2000 degrees Fahrenheit in the gases outside the superheater, and a temperature averaging, say, 600 degrees Fahrenheit within the superheater; so that with a difference of temperature of 1100 degrees Fahrenheit, or so, a certain amount of heat per hour is transmitted to the superheater surface —say enough to superheat the steam 200 degrees Fahenheit. Now, if we assume these conditions with dry steam, what will happen if 10 per cent. of moisture be added? Ten pounds of dry steam requires only about 1000 heat units to superheat it 200 degrees, but if you have nine pounds of steam and one pound of moisture, nearly the same amount of heat will be required to evaporate the water before any superheating whatever will take place.

The question then arises, will the superheating surface supply the extra heat required to give the same superheat as before? The supply of heat is determined by the rate of transmission of heat through the superheater surface, which, again, is dependent on and proportional to the difference of temperature between the inside and outside of the superheater. This difference of temperature, it will be seen, has changed very little in the case of the wet steam; that is, it may average 100 degrees or so greater, which is not much when added to 1100 degrees. Moreover, as the priming is apt to be worse when there is a heavy load and when the superheater is called upon to heat much more steam than normally, this little advantage in temperature difference will be more than overbalanced. We may then say that roughly each per cent. of moisture in the steam supplied to the superheater is capable of destroying about 20 degrees of superheat.

The moral, then, as pointed out, is that the water must be kept out of the superheater. To this end there are various means. Priming and foaming may be produced by suspended impurities and dirt in the water rising to the surface and forming scum, or by concentration of salts, particularly those of the alkali metals, sodium and potassium, and the metal-like compound ammonium. Caustic soda, sometimes used in cold-process softening systems and in boiler compounds, is particularly apt to cause foaming if in excess. Foaming is also apt to occur in boilers which have been coated with scale and subsequently have been fed with softened water or with compounds, as the latter loosens some of the scale and disintegrates it in the body of water. Other causes contributing to priming and foaming are: The way in which the engines are operated; the method of controlling the boiler-feed pumps; the location of the feed-water inlet; the method of firing under forced draft; failure to blow down regularly or sufficiently; failure to clean the boilers regularly; and the type of boiler.

It is principally to the latter point that Mr. Greth would direct attention, but it should be remembered for one thing that while there is some difference in boilers, the large number of boilers now in use cannot be changed at once; we must get along with them somehow as they are by suitably adapting methods of operation. Further, there is practically no type of boiler that will not prime under adverse conditions. It appears therefore, that there is more hope of securing satisfactory operation in a practical manner at small expense by, first, more careful attention to cleaning and blowing down boilers, as suggested, second, keeping as much as possible of sediment, carbonates, etc., out of the boilers by providing for their precipitation in open heaters, and, third, the installation of arrangements for controlling the boiler-feed pumps so that a uniformity of inflow can be obtained at all times equal to the rate of evaporation, thereby maintaining the water level at a fixed point which can be somewhat lower than the level usually adopted with hand regulation, for, as is well known, the water tender often carries a high water level in order to be on the safe side.

A uniform inflow of feed water is not only advantageous as regards priming, but also increases the efficiency of feed-water heaters and economizers, inasmuch as the water is pumped through the heater uniformly as the exhaust steam is delivered, or as the gases come through from the furnace; whereas, if the water were rushed through in spurts, much of the heat of the exhaust steam or of the chimney gases would be irretrievably lost.

There are now a number of automatic feed-water regulators on the market that give almost ideal conditions; that is, a smooth even stroke to the pump and a water level that does not vary more than a half inch under the greatest fluctuation of load. The writer knows of one case where regulators were installed on a battery of boilers receiving their feed supply from an open heater. A recording thermometer in the feed pipe had previously shown wide fluctuations in the feed temperature which varied from 210 degrees Fahrenheit down to 150 degrees Fahrenheit, or 160 degrees Fahrenheit. After the regulator was installed, however, the feed temperature was held very uniformly between 205 and 210 degrees.

So much for securing non-priming conditions in the boilers; but as in many cases, due either to the type of boiler, character of water, or overload, priming cannot be eliminated entirely, it is always advisable to install a steam separator between the boiler and the superheater, if for nothing else than to prevent the possibility of slugs of water going over into the steam lines, especially in a steam-turbine plant, for, as J. R. Bibbins stated in a recent paper: "In the design of several turbine plants separators have been dispensed with, anticipating the use of superheat. Invariably, at one time or another, a large quantity of moisture has found its way to the turbine."

Mr. Greth apparently doubts that an efficient separator can be built. Nevertheless, there are separators on the market, of the single-baffle, direct-impact type, which not only do not require cleaning, but are thoroughly efficient in removing water. The makers of such separators regularly guarantee them to de-

liver steam containing less than ½ of 1 per cent. (0.005) of entrained water, without regard to the quantity of water in the steam entering it and with capacity dependent only upon the removal from the separator well of the water taken out of the steam.

That the use of such a separator would result in a marked improvement in conditions is apparent from Mr. Greth's statement that, from tests made on a large number of boilers, the average moisture in steam is found to be considerably above 1 per cent. It should be remembered at the same time, that the amount of water that gets by the separator is roughly proportioned to the amount that enters it, and the above figure, ½ of 1 per cent. by weight of the steam, is the maximum under severe conditions. With only a small amount of water in the steam originally, the amount passing through would be very minute.

GEORGE H. GIBSON.

New York City.

Homemade Boring Bar

Having occasion to bore out the hub of a pulley from $1\frac{1}{16}$ inches to $1\frac{1}{8}$ inches on short notice, the nearest machine shop being thirty miles away, after a little thinking my assistant and I went to work on the device described herewith. We took a piece of shaft about 2 feet long of the same size as the bore of pulley and drilled an 8-inch hole half-way through about 4 inches from the end of the shaft. A cutting tool was made and driven in the hole in the shaft as shown at *A*, Fig. 1. We then set the shaft in a vise and put the pulley on the shaft down to the cutting tool, turning the pulley by hand and bearing in all the while. We got along nicely until we came to the set-screw hole, then every time the cutter came to the hole we got stuck by the cutting tool taking too big a bite in the hole. To overcome this we drilled the hole through the shaft and then took a piece of round, blunt steel and made it the shape of the cutting tool, as shown at *B*, Fig. 2, so that as we turned the pulley, when the cutter came to the set-screw hole, the shoulder that had been made in the pulley came against the end of the blunt piece of steel opposite the cutting tool as shown at *A* and *B*, Fig. 2. We bored first from one side and then from the other, finishing in the center. A sleeve, however, could be made out of babbitt or iron, if needed, to finish up with, in case the bar was not going true, but on our job nothing was used.

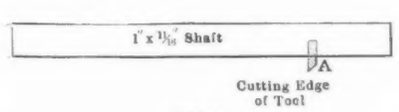


FIG. 1

In case one has a pulley without set-screws or key-seat, the description in Fig. 1 will be all that is required. By making the tool as shown in Fig. 2 the blunt iron *B* opposite the cutting tool *A* is convenient to drive the cutting tool out with or to shim between them in case the cutting tool becomes worn or broken off too short.

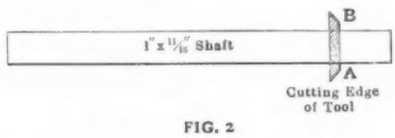


FIG. 2

JOSEPH URBANEK.

Schuyler, Neb.

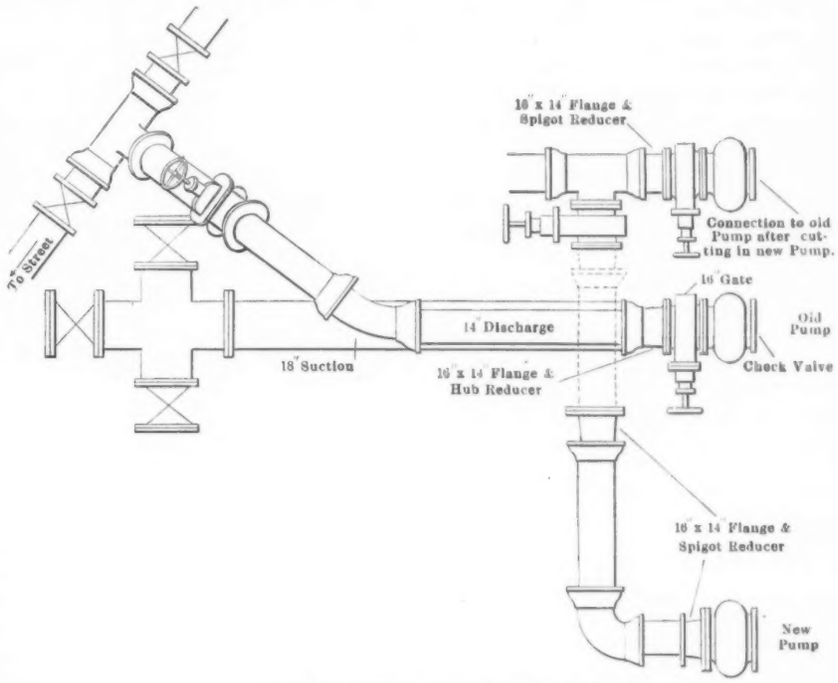
An Emergency Pump Connection

Very often an engineer is confronted with the problem of connecting a new unit to an old system with the least possible hindrance to continuity of operation.

In one case of the writer's experience, a 4,000,000-gallon pump had been installed to supply water to a city of about 18,000 inhabitants. It became evident, however, that another pump of equal capacity was needed as a reserve, it being found that two old Gordon pumps, installed years before, could not do the work required.

In installing the first pump no provision had been made for connecting a new pump into the discharge line to the city mains, hence it would be necessary to cut the old line, necessitating a complete shut-down of the entire waterworks system while a tee was placed in the line.

Some idea of the conditions may be obtained from the sketch herewith shown. On this charge line of the old pump, a 16-inch check and a 16-inch gate valve were located next to the pump. A 16x14-inch flange and hub reducer connected to the 14-inch line, which led out and down to the 14-inch main feeding the system. To connect the new pump it was necessary to cut the 14-inch line near the old pump and insert a special tee having 14-inch hub ends on the run and a 16-inch flange outlet. A 16x14-inch flange and spigot reducer was also needed to connect the tee to the 16-inch valve on the old pump.


16" x 14" Flange & Spigot Reducer
Connection to old Pump after cutting in new Pump.
16" Gate
Old Pump
Check Valve
14" Discharge
18" Suction
16" x 14" Flange & Hub Reducer
16" x 14" Flange & Spigot Reducer
New Pump
To Street

OLD AND NEW PUMP CONNECTIONS

To make the time of shut-down as short as possible, the new 16-inch valve was placed at the outlet of the tee so that as soon as the latter was calked in place, the valve would be bolted on the outlet and closed so that the old pump could be started again and the new pump connected up at leisure.

The new pump was placed parallel to the old one, the transverse center lines coinciding, and connection made to the discharge line by running from the new 16-inch valve with a 16x14-inch flange and spigot reducer, a length of 14-inch cast iron pipe, a 14-inch "condensed" ell with hub ends, a 14-inch cast iron nipple and a 16x14-inch flange and spigot reducer connecting to the check valve of the new pump.

The reason for not running from the

new pump to the inch tee with a 16-inch pipe was that a quantity of 14-inch pipe was on hand and as special flange and spigot fittings were necessary in any event, the plans were so drawn that the 16x14-inch flange and spigot reducers used to connect the old 16-inch valve to the tee could be used also to make the connections between the flange fittings and the bell and spigot pipe in the new part of the discharge line.

The connection to the suction line was easily made at one outlet of an 18-inch cross which had formerly connected to an old reservoir.

In designing the 16x14-inch flange and spigot reducer, the length from the back of the flange to the end of the spigot was determined by the amount of room required between the flange of the reducer and the hub of the tee to calk the joint. One foot would have been ample, but fifteen inches were allowed. To this was added the amount that the spigot end of the reducer would enter the hub, which was 4 inches, the standard for a 14-inch bell.

GEORGE W. MARTIN.

Pine Bluff, Ark.

Combustion or Total Heat Formulas

The writer, having occasion to use a combustion formula in his work a short time ago, was undecided as to which one to use of the number he had at his command. It was this indecision and lack of confidence in the various equations which led to an investigation, the result of which is set forth in the following:

D. K. Clark, in his "Manual of Rules, Tables, and Data for Mechanical Engineer," gives the following equation:

$$h = 145 \left[C + 4.28 \left(H - \frac{O}{8} + 0.28\, S \right] \right.,$$

where

h = Total heat of combustion in B.t.u.,
C = Per cent. carbon in 100 parts,
H = Per cent. hydrogen in 100 parts,
O = Per cent. oxygen in 100 parts,
S = Per cent. sulphur in 100 parts.

Dulong gives:

$$h = 14{,}500\, C + 62{,}100 \left(H - \frac{O}{8} \right).$$

The *Vereines deutscher Ingenieure* gives:

$$h = 81{,}000\, C + 29{,}000 \left(H - \frac{O}{8} \right) + 2500\, S - 6.0\, E,$$

in which allowance is made for the heat of combustion of sulphur and the heat of the hygroscopic water. The coefficient for hydrogen, 29,000, is the one in which the water is supposed to be as aqueous vapor, all the water being considered as passing off in that state; h is in calories.

Balling gives:

$$h = 8080\, C + 34{,}462 \left(H - \frac{O}{8} \right) - 652\, (E + 9\, H),$$

which he states represents the actual occurrences in a steam-boiler fire working under a pressure of steam corresponding to 300 degrees Fahrenheit. This equation gives the heat in calories.

Schwackhoefer made the following modification to allow for the correction due to hygroscopic water:

$$h = 8080\, C + 34{,}500 \left(H - \frac{O}{8} \right) - 637\, E.$$

Mahler formulated one based on the results of calorimetric determination of the heat of combustion of forty-four different kinds of fuel:

$$h = 14{,}650\, C + 62{,}100\, H - 5400\, (O + N).$$

The results are in B.t.u.

In summing up he says: "From a scientific point of view, in the present state of our knowledge on the subject, we cannot give a general formula depending strictly on the chemical composition which will give the calorific power of combustibles, substances so complex and varied."

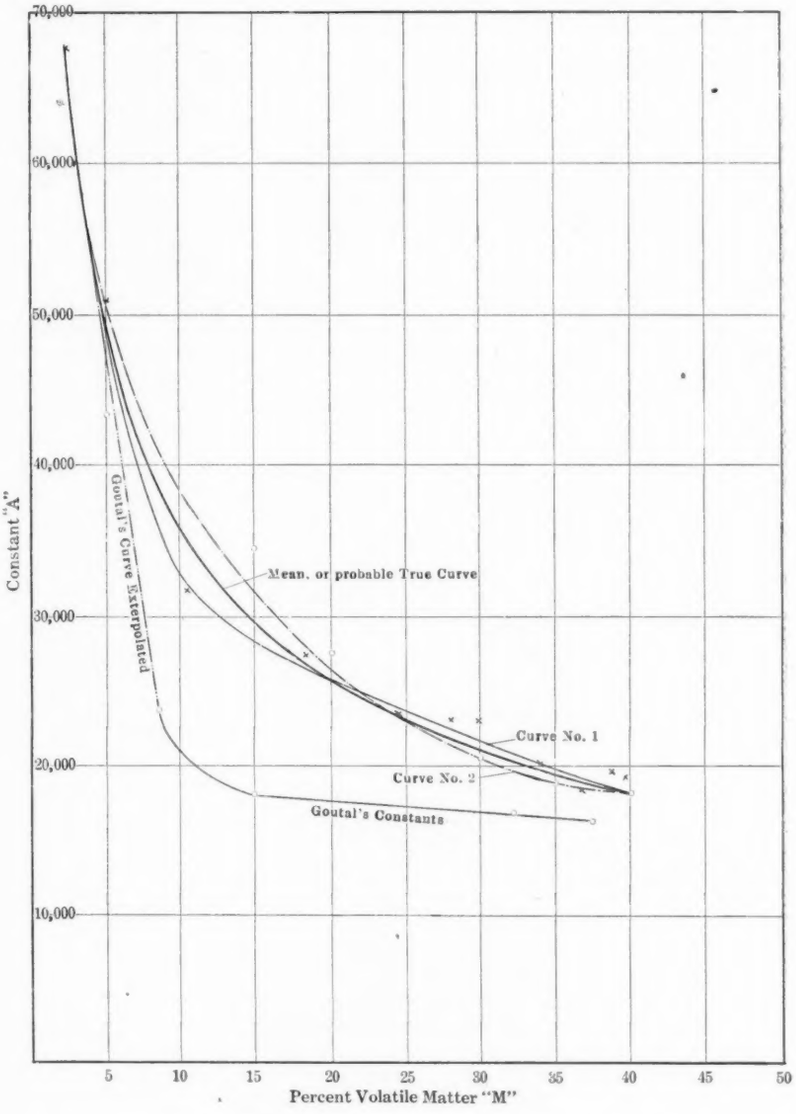
Bunte gives:

$$h = 8080\, C + 28{,}800 \left(H - \frac{O}{8} \right) + 2500\, S - 600\, W,$$

where S and W represent the percentages of sulphur and water respectively. It is, however, inapplicable to anthracite.

The results obtained by all these formulas for anthracite coal are, as a rule, considerably too low.

The question as to the advisability of correcting the formulas for the heat due to sulphur is a debatable one. It would scarcely seem that it would be worth considering unless high, 1 per cent. affecting the result but 0.3 per cent.



CURVES FOR CALCULATING THE HEAT OF COMBUSTION OF COAL

Goutal gives:

$$P = \frac{8150\,C + A\,M}{100}$$

as being more readily applicable than any of the others quoted and as being more accurate.

In the above formula,

P = Calorific power in calories,
C = Percentages of fixed carbon, = (Coke-ash),
M = Percentage of volatile matter, = 100 — (coke + water).

A is a coefficient which varies with the amount of volatile matter thus,

M 2 to 15	A 13,000
M 15 to 30	A 10,000
M 30 to 35	A 9,500
M 35 to 40	A 9,000

These formulas were tested out on a bituminous coal, which analyzed as follows:

Location, Name of.	Fixed.	Carbon Volatile.	Total.	Hydrogen	Oxygen.	Nitrogen.	Sulphur.	Water.	Ash.	Heat Units of Combustible. Calories.	Heat Units of Combustible. B.t.u.	Authority.
Carnegie ..	56.20	36.42	77.20	5.10	7.22	1.68	1 42	1.45	5.93	8304	14,947	Lord & Haas.

Following are the results of the tests:

		Error Per Cent.
Clark	13,859	7.27
Dulong	13,8 2	7.65
Vereines deutscher Ing...	7,432	9.7
Balling	17,376.4	11.2
Schwackhoefer	7,677.5	7.55
Mahler	13,996 3	6.36
Bunte	7,482.9	9.88
Goutal	7 850.1	3.29

The next step was to investigate the formula which gave the least percentage error.

Goutal's formula can be changed to B.t.u. by multiplying by 1.8; it then reads:

$$h = \frac{14.670\,C + A\,M}{100}.$$

M 2-15	A is 23,400
M 15-30	A is 18,000
M 30-35	A is 17,100
M 35-40	A is 16,200

If we now take the formula and rearrange the terms so as to solve for A, we get:

$$A = \frac{100\,h - 14.670\,C}{M}.$$

I then took Poole's tables on the calorific power of fuels and substituting the values of h, C and M solved for A, and plotted the results to get a continuous curve which would give simultaneous values of M and A. These curves are shown on the plot together with Goutal's values. Curve No. 1 was first plotted, each point marked with an x being the average of at least five computations. Next another set of coals entirely independent of the first set was chosen and the values of A again determined. These values were so chosen as to give the possible maxima and minima values. The curve marked "mean" was then interpolated as being the probable true curve for the data chosen. This curve was then tested on several other samples of coal, the constant A being determined from the plot and inserted in the formula, the resulting heat of combustion being then compared with the values given in the table. In almost every case the error was slightly above the calorimeter values.

It would seem, then, that this formula was more flexible and had a greater adaptability to a larger range of coals than any of the ones quoted. With the curve just given one can calculate the heat of combustion of almost any American coal, with a very reasonable degree of accuracy. It must not be inferred from this that two coals having the same percentage of fired carbon and volatile matter will contain the same number of heat units. For this depends upon the composition of the volatile matter, i.e., whether it contains CH_2 CH_4, etc., but it can be readily seen that there is an approximate law which is concisely expressed by Goutal's formula, depending only on the per cent. of fixed carbon and volatile matter, and which can be used when it is impossible to obtain a calorimetric determination.

HAROLD COES.

New York City.

A Trap Solved the Difficulty

About five miles from the spot where this article is being written is a plant of respectable size engaged in the production of charcoal by the retort process, acetic acid and crude wood alcohol (methyl hydrate) being side products of considerable importance recovered from the distillate.

Evaporation at two or three stages in the various operations in the production of the calcium acetate, and later in the production of the crude alcohol, is effected by steam being led into coils submerged in closed iron vessels constituting the distilling apparatus.

The expert who had installed several plants of this kind in different parts of the country remained with this particular plant as its permanent chief.

The plant had been in operation two or three years and the fuel consumption had been extravagantly high.

The capital which had been sunk in the enterprise was followed up by more capital, but dividends were not forthcoming and conditions were such that operation meant positive loss. When this state of affairs developed, the owners felt that something must be done, and if this was expert operation, no operation at all would be more desirable.

A practical engineer was asked to look the plant over and make suggestions for improvement. The following is part of what he found:

The drip from the steam coils in the distilling apparatus was allowed to discharge into a vessel open to the atmosphere, the water running from this vessel to another receptacle, being purposely made to fall through a certain distance in the form of spray in order to cool it sufficiently to be picked up by an injector and forced back in the boiler. The great stickler seemed to be to cool down this water so that it would be at a temperature the injector could handle without trouble.

The absurdity of burning fuel to heat water and then taking considerable pains to waste the heat in the water when available for use did not seem to occur to the owners or expert in the course of two or three years' operation of the plant.

The engineer called in for consultation suggested the use of a steam trap of sufficient size, and so located that the water would be taken at the temperature at which it left the coils and returned to the boiler without any ceremony or loss of heat units. The expert fought this idea and claimed it could not be done. Our all-round man said it was not an original experiment; that it had been done, and that its application could be found in heating systems all over the country, and that the case under consideration could be regarded as a heating system, as it was nothing more than the generation of steam from water, the condensation of the steam and its return to the boiler for reheating to put it again in the condition of steam.

The expert's arguments were of no avail for he had failed to give satisfactory results in the operation of the plant. Our practical man, after returning home, was taken ill and the expert improved this opportunity to talk the owners out of the practical suggestions that had been made.

Word was sent to the engineer to be on the ground and defend his principles; as he could not, he sent the best representative he could find to insist on having his instructions carried out in the matter, which was finally done.

Before the practical engineer was sufficiently convalescent to leave his room he was visited by the two owners, who could not defer their visit any longer, so anxious were they to tell him that he had put their plant on a paying basis, that instead of being hard pressed for fuel they had plenty to sell.

The expert severed his connection with

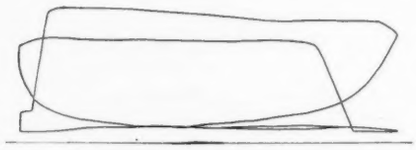
the plant, but he did not leave town until he called on the man who invaded his territory and said: "Mister, I have had the greatest eye-opener I ever got in my life; I have installed a dozen such plants as this one in different places and I am going back to remodel them."

T. H. REARDON.

North Adams, Mass.

A Case of Bad Valve Setting

The accompanying indicator diagrams were taken from a 16x18-inch piston-valve



MR. STAUFFER'S DIAGRAMS

engine. I wish that someone who knows would tell me what is wrong with them.

E. A. STAUFFER.

West Cape May, N. J.

Cutting Packing

In a recent number there was described a "rough and ready" method for cutting packing and economizing in its use. The scheme seems practical but I suggest a few additional pieces to enable the engineer to do the cutting more accurately and quickly. Fig. 1 shows the apparatus which I have planned like a miter box.

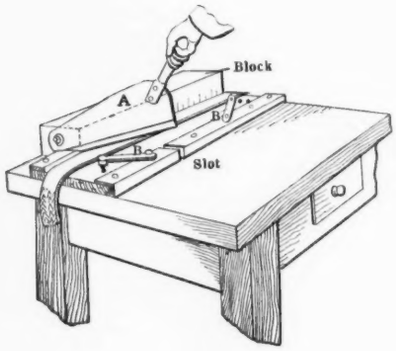


FIG. 1

The packing is held in a wide, flat groove, which admits of any width up to 4 inches, and is held by the two metal pins *B B*, fitting into holes in the groove corresponding to the required width of the packing. The knife blade *A* is bolted to the large block at an angle of 45 degrees and falls in the slot cut for it, thus cutting off the packing. The entire miter or cutting box may be screwed upon the bench or removed when not in use, as it is made to lift in one piece.

Fig. 2 shows a plan of the box and method of holding the packing against the graduations on the block by which the proper lengths can be cut off.

In Fig. 3 I suggest a home-made apparatus for cutting packing rings from

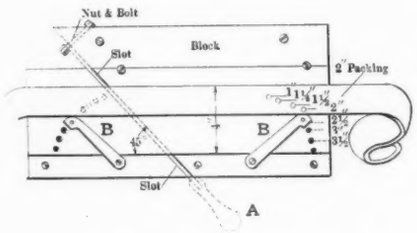


FIG. 2

stock to the thickness required. A piece of iron pipe, the inside diameter of which will allow the packing stock to be drawn in freely, is clamped by a pipe clamp or hook upon a wooden block and a slot cut in it to allow the knife blade *B* to travel to the bottom of the inside diameter but not clear through the pipe. This knife blade is pivoted to the board by an iron bolt and strap. A measured index marked outwardly from the slot upon the baseboard enables rings of any desired size to be quickly cut to uniform thickness.

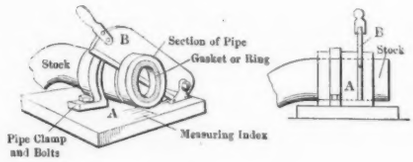


FIG. 3

Fig. 4 shows a simpler form for the same purpose. An iron strap slightly rounded to allow several sizes of packing stock to be held under it is bolted on top of a block, at the other end of which the knife edge is pivoted as before. The stock can be drawn along under the knife and any desired length cut off as measured by the measuring index marked upon the base block. This apparatus can be unbolted

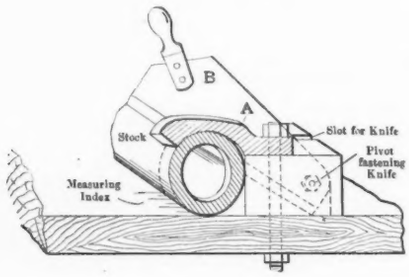


FIG. 4

and removed with one operation when in the way.

In wood-turning and sash shops, planing mills, etc., where circular-swing saws and band saws are available, the simple scheme shown in Fig. 5 would make quick work for the engineer. Two bands of 2x½-inch strap iron are curved exactly alike, the curve being calculated to accommodate 4-inch stock at the larger end and not larger than 2-inch at the small end. These straps are bolted to the bench or to blocks setting on the bench on either side, close to the saw slot of the circular-swing saw. If a 3½-inch gasket or packing ring is to be cut off it is put in under the straps and held in place against it by small wooden blocks braced against the large end and

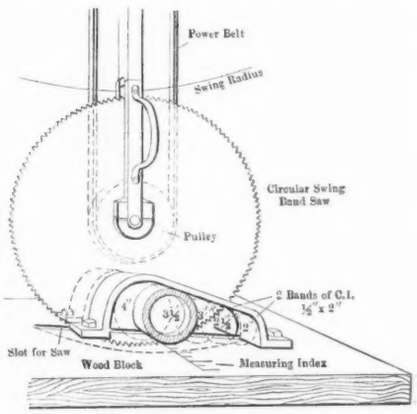


FIG. 5

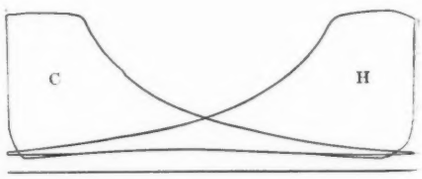
then cut off with one pull of the swing saw coming down between the straps. The thicknesses required are marked off on the bench from the slot out as before.

F. W. MOORE.

New York City.

Diagrams for Criticism

The accompanying diagrams were taken from a cross-compound engine, and give an idea of our every-day running condi-



HIGH-PRESSURE CARD

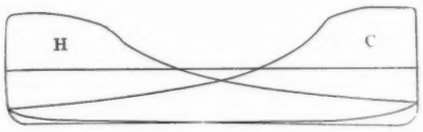
tion. I would like to have them criticized by engineers, as I am very anxious to learn in what way they may be improved.

The diameter of the high-pressure cylinder is 26 inches; stroke, 52 inches; revolutions per minute, 45; boiler pressure, 150 pounds; vacuum per gage, 25 inches; scale of spring, 80. The low-pressure cylinder is 52 inches in diameter; scale of spring, 20; receiver pressure, 10 pounds.

At the time these cards were taken we were carrying 50 pounds on our dis-

charge line and 6 pounds on the suction, and running 45 revolutions per minute.

We pump gas from gasfields scattered over an area of about 30 square miles to Pittsburg through two 12-inch mains laid across the country, a distance of about 65



LOW-PRESSURE CARD

miles, and endeavor to maintain 25 or 26 pounds pressure per square inch on a 30-inch main in the city.

D. H. YODERS.

Clarkesville, Penn.

Separators Should be Covered

No steam apparatus have been and are daily neglected as are the so-called steam separators, many of which are steam condensers rather than separators. Possibly

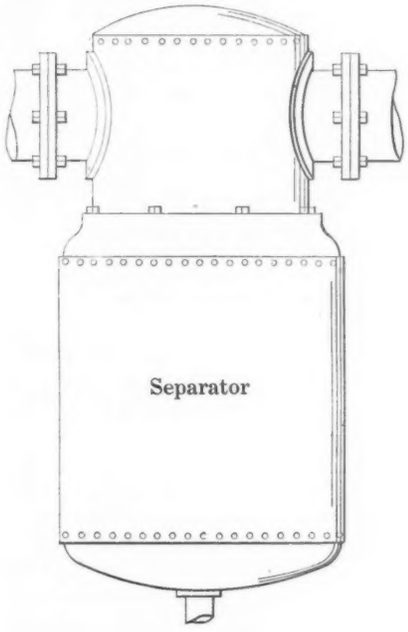


FIG. 1

they should be called water eliminators, when properly built and installed, but from practical observation about nine out of ten are condensers and water "traps to wreck the engine." Connected with a steam separator usually there is a "steam trap," which is supposed to drain the separator automatically, but many of these traps are virtually "traps," and fail to work when needed. A device that is intended to drain the water from a steam line should be the best and most reliable made, and from the writer's practical experience none are too trustworthy under the most favorable conditions. Such devices are dangerous when carelessly in-

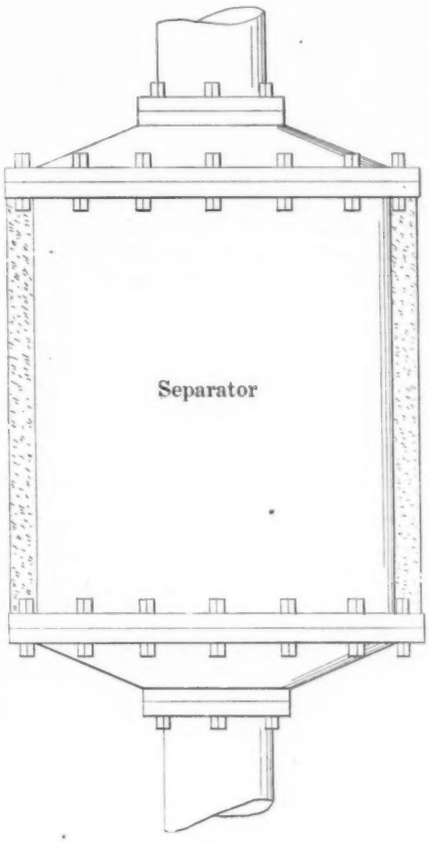


FIG. 2

stalled and looked after, as they will gather the water and cause it to siphon over into the engine, causing it to wreck itself.

Many steam separators are improperly

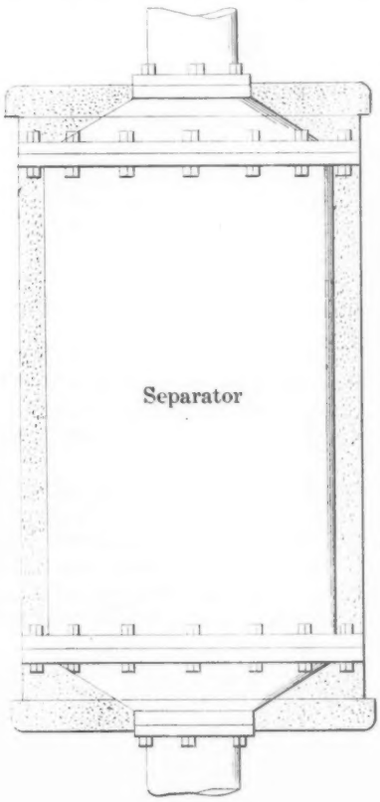


FIG. 3

built and installed. It is not uncommon to enter an engine room and find a large cast-iron separator in the steam line, without any covering, although the steam pipe will be covered. This tends to make the separator a condenser to a large extent, condensing the steam. The separator presents as much surface as a considerable length of steam pipe, yet the separator is bare. Much of this is due to the manufacturer, the separators being built in such manner that they are difficult to cover; consequently, they go uncovered. Nearly all steam separators require a paste covering. Many are built like that shown in Fig. 1, with flanges that make it hard to cover them properly. In case of repairs being necessary the covering would have to be torn in order to pack the flanges.

Fig. 2 shows another style of separator. This has room for covering material between the body of the separator and the outside jacket, which is a good thing, as the person installing the separator does not have to look after the covering, this being done when the separator is built.

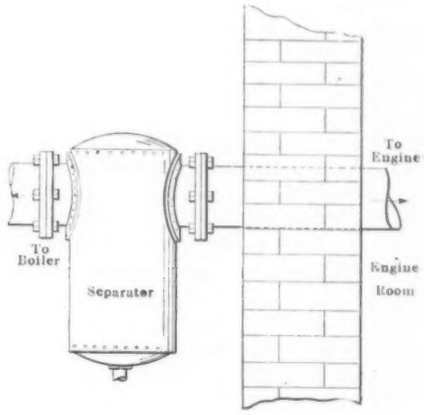


FIG. 4

The ordinary separator always has to be covered with an insulating cement, put on wet, and this is more trouble than putting on the ordinary pipe covering, which is ready prepared.

Fig. 3 shows a better way to construct a separator, by having a casing forming the outside shell and capped top and bottom, the casing being filled with a steam-insulating material. These heads could be cast so as to come over the outside casing as shown and would make a satisfactory covering jacket.

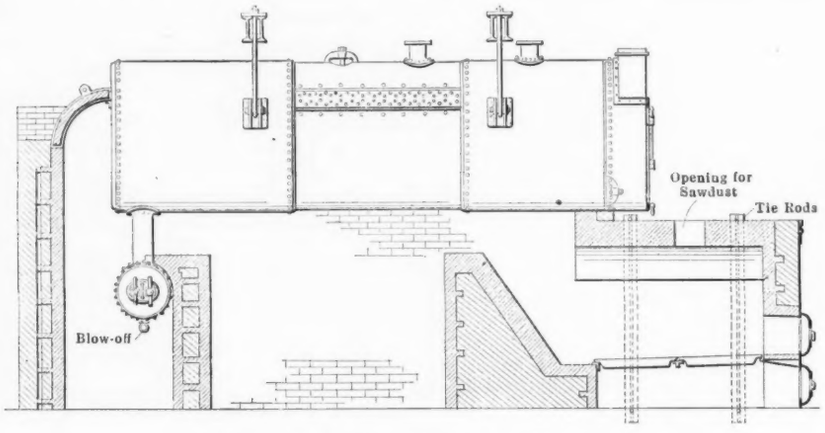
Separators are sometimes placed in queer places. In Fig. 4 is shown one placed outside of the engine room. The boiler room was separate from the engine room and the steam pipe ran outdoors. The pipe line was covered, but the separator was not. It had a trap to drain the water off and this pipe was frozen up at the time the writer saw it. This certainly was a steam condenser. All of this surface was exposed to the atmosphere.

C. R. MCGAHEY.

Lynchburg, Va.

Sawmill Boiler Setting

The illustration shows the setting of one of a battery of three 72-inch by 18-foot tubular boilers used for sawmill purposes. They are suspended from I-beams which are supported upon cast-iron columns by means of eye-bolts extending from the beams to hinge straps riveted to the shell. Cast-iron columns should be



SECTIONAL VIEW OF FURNACE SETTING

set on the outside of the brick walls, and not in the walls close to the lining of the combustion chamber, as is sometimes done, as the brick lining will fall off and leave the columns exposed to the fire.

Every brick in this furnace above the grates should be laid a header, the top arch a half circle or nearly so, and of sufficient hight to allow of ample area for combustion and even distribution of draft. The walls under the arches between the boilers should extend back to the bridgewall.

Placing the furnace so the top feed hole will come as close to the smoke-box of the boiler as possible requires somewhat less material and labor, with the advantage of having the products of combustion impinging on the first sheet.

The fuel for replenishing the furnace when the mill is not sawing is stored on the deck level with the top of the ovens, and is shoveled or pushed into top feed hole as needed.

In order not to choke the draft and decrease the rate of combustion, the top of the bridgewall should be a sufficient distance from the top arch of the oven to allow ample area between the grates and the boiler. The flat place at the bottom of the bridgewall retains the slag, which continually runs down, where it can be easily removed instead of clogging the rear of the grates. The mud-drum is considered by some to be a useless appendix to a tubular boiler. Besides the advantage of a depository for sediment which collects in it, it has no equal as a means of equalizing the water level in a battery of sawmill boilers.

In the plant where I am employed we have six 72-inch by 20-foot boilers set in two batteries of three each. That is, we have two combustion chambers and two mud-drums. Instead of maintaining six water levels the fireman has practically to maintain but two, while he has three gages of each level, one being a check on the other. In place of six blow-off pipes and valves, that are a continual annoyance and must be blown out several times daily, we have but two, and it does not make much difference if they are blown regularly or not, considering the fuel and method of firing and the varying demands for steam.

To prevent the hot gases from direct contact with the mud-drum and nozzles, a wall in front of the mud-drum with triangular piers in front of the nozzles is as good a plan as any, and preferable to an arch over the drum. The large cavity behind the bridgewall is an advantage in obtaining the greatest steaming capacity, due to a more equal temperature under the boilers as unconsumed fuel and cinders drawn over the bridgewall are largely deposited there and further combustion takes place. The chamber under the return arch does not readily become filled with cinders and ashes, and there is less liability of setting the yard or buildings on fire from sparks coming out of the stack.

The unequal distribution of draft in some designs of breeching or smoke flues between boilers and stack usually can and should be corrected by the proper use of diaphragms, baffle plates, etc.

Owing to the compactness of sawdust and unskilful heavy firing a fairly intense draft is essential to obtain maximum steaming capacity, which by natural means can only be had by having a stack of sufficient hight, usually 100 feet or more above the grates.

Feeding the water into the mud-drum somewhat prevents sediment from settling in it. A good top feed designed to give as nearly an equal delivery to each boiler as possible should be employed.

An equal pressure of steam between boilers is assured by a common steam dome with large nozzles or large equalizing pipes.

GEORGE J. PICKER.

Everett, Wash.

Reducing Oil Consumption of Pump

Four years ago, when our new plant was started, we got the cylinder-oil consumption on our boiler-feed pumps down to one drop in 40 seconds. For the last year I had noticed a gradual increase in the cylinder-oil consumption of the pump room. But as we were trying out samples of various oils at the time, I thought the trouble was due more to the oil than the pumps.

As we adopted a brand of oil best suited to our conditions, about the first of the year I turned my attention to the reason for the pumps taking six or eight drops per minute to keep them from groaning. Upon taking the steam-chest cover off one of them, I found that the valve travel was ¼ inch short at each end of the length of the valve seat, Fig. 1, leaving a shoulder for the valve to butt against. The valves were worn convex and the seats worn concave.

I had our machinist plane off and

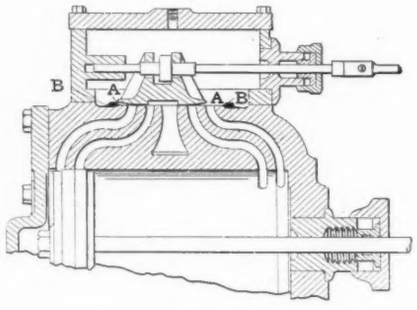


FIG. 1

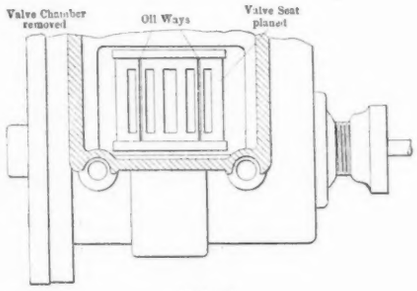


FIG. 2

scrape the valves, scrape the seats and cut off the ends, as shown at *B*, so that the valves would travel just over the edges, similar to the piston-rings over the counterbore in the cylinder. Then as there seemed to have been cutting on the bridges of the seats, at *A*, in Fig. 1, I had him cut small oil ways the length of the bridges to the outer edges of the seats, Fig. 2, so that oil and steam could work under the valves and lubricate them at

that point. As the lap of the valves cover these bridges at all times, steam could not leak through into the exhaust.

Upon starting the pump we found we could cut the oil down to two drops per minute. And after a week, when we had established a glaze on the valves and seats, we cut the oil to one drop in 2 minutes. Spending $5 for a machinist has saved us about 10 cents worth of oil every day, to say nothing of the steam wasted.

G. H. KELLOGG.

Syracuse, N. Y.

An Appeal Examination

After reading the letter, "An Appeal Examination," by Joseph King, in the July 14 issue, answering the questions the examiner asked, and who, according to Mr. King's statement in the May 12 issue, refused him a first-class license, I must say that he was justified in so doing, if Mr. King's answers were the same as published.

I will here take up but two of the questions, the answers to which I contend are wrong. The first is his determination of the safe working pressure of a boiler 72 inches diameter, ½-inch sheet, and triple riveted, double-butt strap joint. Mr. King gives the safe working pressure on this boiler as 172.9 pounds per square inch, which is far above safe practice.

In determining his joint efficiency he is correct; his mistake is in taking too small a factor of safety. According to the most eminent engineers on boiler practice, we should use at the very least a safety factor of five, and in many instances six, in which case we would have

$$\frac{\frac{1}{2} \times 2 \times 60{,}000 \times 0.83}{72 \times 5} = 138.3$$

pounds per square inch.

This would be all any insurance company would allow on this boiler, as a safe working pressure, and if "Lloyds" were consulted it would be still less. A boiler manufacturer would allow approximately 135 pounds.

As to the question of the safe working pressure on this boiler without tubes or stays, I notice Mr. King is only using a safety factor of five, whereas eight should be the very smallest for unstayed flat surfaces, and still the safety would be very uncertain. According to this, we would have

$$\frac{\frac{5}{8} \times 60{,}000 \times 10}{4073.1 \times 8} = 11.6$$

pounds per square inch. This shows that in this case, Mr. King is 80 per cent. too high. This, I think, would be a sufficient reason for an examiner, if he fills his office conscientiously, to refuse a man a first-class license.

C. M. HANSEN.

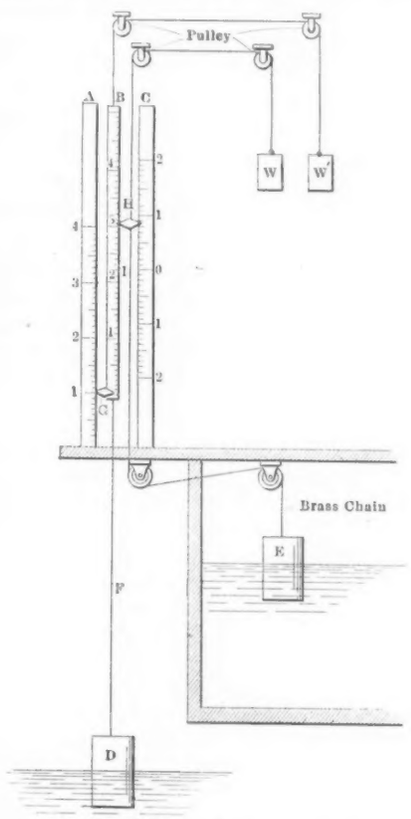
Pittsburg, Penn.

Apparatus for Recording Hight of Head and Tail Water

By means of the apparatus shown herewith the hight of the tail water, hight of the head water and the fall may be noted at a glance.

The apparatus consists of two floats *D* and *E* and three graduated strips *A*, *B* and *C*. Strips *A* and *C* may be made of any convenient pieces of board, but *B* should be made of some light material a little longer than the greatest difference between the head and tail waters, graduated in feet and inches, or tenths of a foot, as desired.

For the floats I used two galvanized-iron cans 6 inches in diameter by 12



APPARATUS FOR RECORDING HIGHT OF HEAD

inches in length. Into the end of float *D* was screwed a piece of ¼-inch iron rod *F* long enough to reach up through the floor when the tail water was at the lowest point.

At the top of the rod *F* was fastened the graduated strip *B*. At the top of *B* a small counterweight *W'* was attached, although this will not be necessary if the strip can be properly guided otherwise. The pointer *G* was set to indicate the hight of the tail water on *A*. The float *E* was connected to the counterweight *W* with a small brass chain running over four pulleys. The water was shut off the wheels to get the correct normal head. The difference in levels was accurately measured and a double pointer *H* fastened to the chain *I*, just the distance from *G* of the difference of the tail water from the head water.

The strip *C* was graduated up and down from zero, and zero was placed at a point where one end of the pointer *H* would indicate the top of the dam, as we sometimes used 2-foot splashboards. The pointer *G* indicates the hight of the tail water on *A*. One end of the pointer *H* indicates the hight of the head water on *C*, while from *G* to *H* indicates the fall, on *B*, and the pointer *H* also indicates whether the head water is above or below the top of the dam.

Reducing levers were attached to *B* and *I* and pens put on the levers so they were made to draw lines on a roll of paper on a drum operated by a clock. Then we had a continuous record, provided the pens were not allowed to run dry.

H. G. CHILDS.

Lansing, Mich.

How Much "Bluff" is Justified?

In one of the monthly magazines there recently appeared a series of articles which brought out that self-consciousness is the cause of, or adds much toward, the despondency and ill-health of many persons. Illustrations were given of people who, when absent from home, worry the entire time as to whether the front door was locked, the gas turned out, etc., with the result that what ought to have been hours of pleasure were in reality hours of self-torture.

It seems to the writer that in the editorial of July, bearing the above title, "bluff" is the word that would commonly be used, but that a strict investigation of the feelings of men seeking or occupying new and responsible positions will result in their feelings being classed as worries. Any man who permits his work to prey on his mind becomes the subject of self-induced worry, which not infrequently renders useless a hitherto valuable and efficient workman.

Every man's judgment is apt to err at times, and the best preventative of worry is the consciousness that during each moment one is doing his level best, that each decision is made with his best judgment. Self-consciousness and the overwhelming fear of an awful mistake in judgment, or an accident as the result of ignorance, then become lost and a man is in his best condition physically and mentally to cope with the problems that come before him. All this applies to the man who has selected, or been selected for, a given position.

What about the man who is offered a position? "Should he seek personal advancement at the possible cost of injury to others?" Does not the physician who has just graduated from a medical college take such risk when he assumes

charge of his first difficult case? And yet, does he not have the consciousness of knowing that he has had the training and the talent which warrant his undertaking it? Does not the young attorney take this same risk in his first case at court? And yet, does he not have a feeling corresponding in some measure to that of the physician? How many clerks, machinists, engineers and others have the absolute consciousness of freedom from mistakes in any duty that comes to them? It is this feeling of confidence in oneself, derived by virtue of knowing one is doing his best, that enables one to make good in such positions. And this feeling of confidence in one's ability and training will not permit a machinist to take a position of electrical engineer, or a boilermaker a position as a surveyor.

I believe that in considering such positions a man should do so in a spirit of confidence in what he knows he can do and what his training has been. If he then decides to take the position, he harms himself by a feeling of constant worry. If he keeps himself busy in the new location, studying all its details, bettering his knowledge where he knows he is weak, and does nothing which will tend to injure his ability to judge promptly and act quickly, he will have no worries, he will not be making a "bluff," but will be making good, both for himself and his employer.

A. A. Andrews.

Norwood, Ohio.

In the editorial, "How Much 'Bluff' is Justified?" I think the matter is put in a form hard to answer. No man should assume any position when he is satisfied that he cannot make good, or even has a doubt of it. Evidently the plant mentioned was large enough to employ other engineers besides the chief. In such a plant the chief ought to make good if he has any tact and ability. There is no harder place for a man to succeed than in the smaller electric-light plants, where he has a runner of little or no engineering ability and must depend upon himself.

When an engineer accepts a position he should exercise the greatest care to see that everything is put in first-class shape as soon as possible. He should size up his men and make sure they are the best he can get.

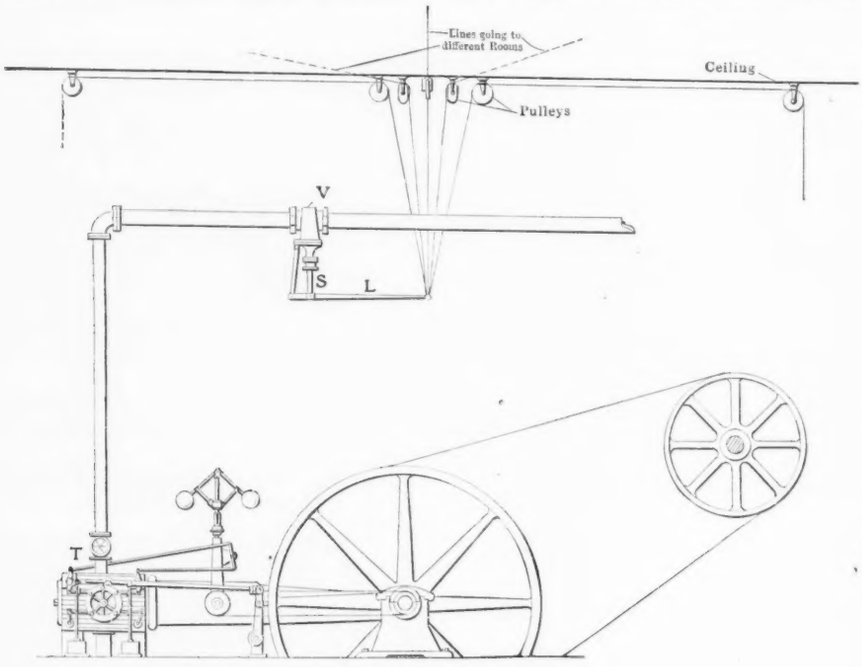
It looks to me as if the would-be boiler inspector was too "raw" and should be "turned down."

F. W. Downs.

Washburn, Wis.

A Homemade Safety Stop

Some few years ago I was engineer in a small factory, doing my own firing besides oiling the shafting and mending belts, so that I was not in the engine room all the time. One day something went wrong in one of the rooms, making it necessary to shut down quickly, and as I was not in the engine room at the time much damage was done before the power could be stopped. I thought of a scheme so that the engine could be stopped at any time from any of the rooms in case of accidents and it worked so well I will give it to the readers of Power and The Engineer. My device consisted of an ordinary gate valve, having a stem worked by a lever instead of a screw. I placed this on the steam pipe between the throttle valve and main stop valve in the boiler room. Referring to the figure it will be seen that the valve is in an inverted position and equipped with a long lever, to the end of which are fastened lines running to different rooms over small ground wheels so as to run easily in any desired direction. The lines are fastened to the end of the lever by means of a ring, another ring being fastened to the other end of each line. When the line is pulled down to shut the valve, the ring is slipped onto a hook on the wall somewhere in the center of the room.



A HOMEMADE SAFETY STOP

The lever is nearly three feet long, so as to make it easy to shut the valve. I used good window cord.

F. P. Kinder.

Saxonville, Mass.

Drop of Voltage Due to Inductive Load

I am operating a three-phase lighting and power plant. We have two incandescent lighting circuits that are supplied separately from two of the three "phases" and our street lights are supplied from the third "phase;" by this method the three phases are fairly well balanced. All motors above 2-horse-power except one 10-horse-power machine are run three-phase, and our motor load in the daytime is so heavy that we are bothered with the heating of the generators caused by the heavy inductive load; on very warm days the voltage lags considerably. This, I am informed, could be remedied by installing a synchronous motor, but as yet we have not found a suitable place for such a machine. Our generating plant consists of one 75-kilowatt belted unit and one of 150 kilowatts direct-connected to a simple side-crank Ball engine, 18x18 inches, running at 225 revolutions per minute on steam pressure of 115 pounds per square inch. The exciters are mounted on the same shafts with the field magnets of the alternators. We use the small unit for light loads, including the night work after 10 p. m.

The reader will notice that the direct-connected unit has more engine power than is really needed for the 150-kilowatt machine. Would it be practical to remove the belt of the smaller machine and run that machine as a synchronous motor during hot days, and if so, about what would be the power required to drive it? I would add that I have started the small machine up as a motor, and while it came up to speed, yet I could not get the voltage up to normal. What was wrong?

I would like to hear from some more experienced engineers regarding this problem.

George C. Woodworth.

Henderson, N. C.

Installing Heating Mains—Correction

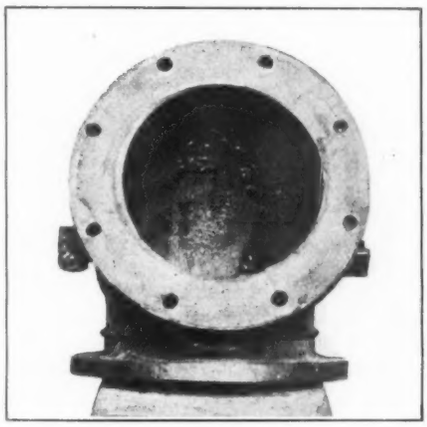
In my article on "Installing Heating Mains," on page 107 of the July 21 number, a slight mistake was made in Fig. 3, in which the letter *D* should have been marked as the passenger station, while *B* and *C* are the boxes where the expansion joints are located. According to the illustration, a 2700-foot run is shown and no provision is made for expansion, which would be in the neighborhood of 13 or 14 inches. Building *D* is about 2700 feet from *A*.

JAMES E. NOBLE.

Toronto, Ont.

Exhaust Steam Wore through Elbow

An interesting case of the action of exhaust steam of a condensing engine on an ell in the exhaust line, came to light in our plant a few years ago. The engine is a duplex, tandem, compound pumping engine of the direct-acting type with



SHOWING ACTION OF EXHAUST STEAM ON ELBOW

a jet condenser located below the steam cylinders, the air or vacuum pumps being direct-connected to the main engines.

After the engine had been in service about seventeen years, it was found that the crown of a special 10-inch ell in the exhaust line, just above the condenser, had been eaten away to a mere shell. By examining the illustration, one can see the dark ragged outline showing the large hole in the center where the crown had been eaten entirely through, while the light pitted spot in the center shows where the patch also had been eaten away to a depth of one-quarter inch. As we could not spare the engine long enough at that time to make a templet and put in a new ell, a pattern was made of plaster of paris and a cast-iron patch was strapped on, using a putty made of white lead, cast-iron borings and dryer, to make it tight. The patch was made to cover the entire crown of the ell. This patch did service for about seven years until a new engine was added to the plant and the old one laid off for general repairs, including the renewal of the ell spoken of. I might add that the other ells in the line were all right, this being the only one affected in this way.

HERBERT C. NICKERSON.

East Haven, Conn.

Belt Lacing

Replying to Earl E. Webster's question on page 912 of the June 9 issue, regarding wire and leather lacing, I will say that I have had a good deal of experience with belt lacing and find that a wire lace will answer for slow-running machinery, but leather lacing is better for fast-running machines. Wire lacing makes a better looking job and runs over a pulley more smoothly than leather lacing.

N. S. LLOYD.

Exeter, Ont.

I have found wire lacing preferable to rawhide. Wire is more durable than rawhide, which soon wears and becomes useless. I have used soft iron wire as a lacing both for leather and rubber belts and found it to be better than copper wire.

GUS A. JANICKE.

Louisville, Ky.

I prefer wire lacing as it is cheaper, neater and is more quickly applied.

I was employed for more than a year in a large factory where one man spends less than one-half his time keeping in repair over 300 belts 2 to 6 inches in width. These belts are laced with ordinary stovepipe wire; nearly one-half of them drive emery wheels, and run at high speed over very small pulleys. The man who does this work claims he is successful because he puts his wire holes about ¼ inch from the end of the belt and about ⅜ inch apart. Wire is almost useless when the stitches are made long, because the wire must bend and straighten out again to a certain extent when striking and leaving the pulleys.

R. MANLY ORR.

Brantford, Ont.

From my experience with wire and leather lacing I prefer the latter because, although it wears out, the former will wear the belt out, and slips much easier than leather over small iron pulleys.

In using leather lacing I always pass it down through the ends of the belt, thus making a hinge in the lacing to prevent the lace from working back and forth in the belt, as will happen when sewed round and round in the usual method.

C. S. BUSHLEY.

De Young, Penn.

Wire lacing traveling over pulleys, say, 24 inches in diameter and upward works very satisfactorily when well laced. It is inexpensive and makes a very smooth, neat joint. I have found, however, that on pulleys smaller than 24 inches, the sharp turn has a tendency to break the wire, especially with a heavy load.

Leather lacing, on the other hand, requires holes punched in the belt about ¼ inch in diameter, which weakens the belt at the splice, and as the leather makes a thick joint it wears considerably in passing over the pulleys and generally wears out at the holes.

I have had a 12-inch main driving belt running over 5-foot pulleys with a wire splice, running 24 hours a day for six months without breaking, while another belt with about one-quarter the load, running from a 20-inch to a 36-inch pulley, broke about every 10 days. I tried wire lacing with leather lacing over the wire to protect it from wear, but it did not last much longer and cost considerably more. So I resorted to clamps, which work very well and divide the strain evenly across the entire width of belt. They have the disadvantage of being dangerous, owing to the clamp projecting and being liable to catch one's clothing, but as these belts run high overhead, I can use them with safety.

For small belts and light loads I have used steel lacing and found it to wear very well, but for heavy loads they are liable to break across the middle when running over small pulleys.

H. STONE.

Round Mountain, Nev.

Wood as Fuel for Steam Boilers

I think there is a slight error in Mr. Johnston's very interesting article on the use of wood fuel in steam boilers in the June 30 issue of POWER AND THE ENGINEER. The specific heat of steam being 0.48 it will not require $340 - 212 = 128$ B.t.u. to raise the temperature of the moisture steam to the temperature of the flue gases, but $128 \times 0.48 = 61.44$ B.t.u.

Since one pound of wood contains only 0.475 pound of moisture, the loss from raising the moisture to steam to the temperature of the flue gases would be $61.44 \times 0.475 = 29 +$ B.t.u. The heat value of the wood under consideration would be $4309 - 461 - 29 = 3819$ B.t.u. instead of 3702, as stated.

ALEXANDER ARNOLD.

New York, N. Y.

G. A. Glick, of Madison, Wis., who has been a frequent contributor to the "Practical Letters" department, writes to state that he is not a professor, as intimated in a recent number, but only a student at the University of Wisconsin.

The number of gallons in a cylindrical tank $= D^2 \times L$ (both in inches) $\times$ 0.0034.

Hydrostatics, or the Equilibrium of Fluids

The Fact Concerning the Compressibility of Liquids, the Transmission of Pressure Through Them, Head and Pressure Due to Gravity, etc.

BY FRANKLIN VAN WINKLE

Liquids are characterized by the ease with which their particles move one upon the other and by having very slight compressibility. The mechanical properties of liquids are determined on the hypothesis that liquids are incompressible,

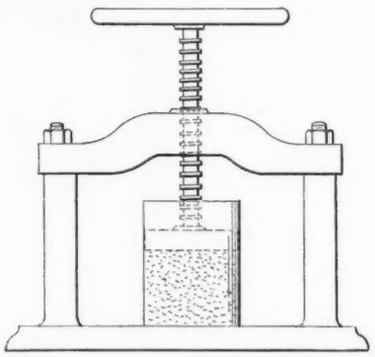


FIG. 1

and the very low degree in which liquids exhibit the property of compressibility for a long time led to the belief that they were incompressible. They are, however, more compressible than most solids.

If a cubic inch of water be pressed with 15 pounds on each and every side, the volume will be diminished $\frac{1}{20000}$,

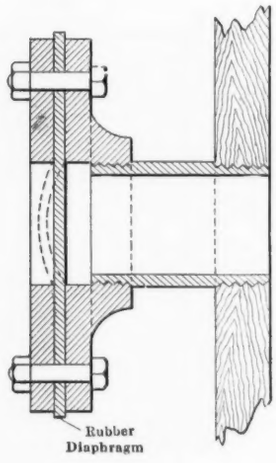


FIG. 2

hence one pound to the square inch will diminish the volume $\frac{1}{300000}$. If the water be confined in a perfectly rigid cylinder and be compressed by a perfectly fitting piston, then compression in the direction of the length of the cylinder would equal $\frac{1}{300000}$ of the length for every pound per unit of area of end pressure. Water is, therefore, nearly 100 times as compressible as steel. All other liquids are more or less compressible, but their compressibility is so slight that for most practical purposes, liquids may be considered and treated as non-elastic fluids.

Transmission of Pressure

In considering the transmission of pressures in liquids, we will first consider them regardless of the effect of gravity. The facility with which particles of a liquid move upon each other causes liquids to comport themselves quite differently from solids when subjected to external pressure. When a solid is exposed to a pressure from above downward, this same pressure will be transmitted in the same direction from layer to layer to the supporting surface without appreciable transmission laterally. Imagine, on the other hand, a cylindrical vessel, Fig. 1, partly filled with a substance like shot or sand; then by means of a piston fitting closely against the walls of the vessel, cause a pressure to be exerted on the surface of the mass of shot or sand by forcing the piston downward. The particles which are directly pressed upon by the piston strive to wedge themselves between their neighboring particles and they in turn, strive in all directions to crowd themselves between the particles surrounding them.

Pressure is consequently transmitted throughout the mass in all directions and finally communicated to the walls of the cylinder, against which it acts everywhere perpendicularly, for, if a hole be made through the wall of the vessel either at the bottom or in the side, the material will flow through the orifice in a direction perpendicular to the wall of the vessel.

If the shot or sand be replaced by oil, water or most any other liquid, the greater mobility of the particles will permit of a more perfect transmission of pressure in all directions. If the vessel is strong enough to withstand the downward and the lateral pressures, we find that the piston cannot be made to descend without causing the liquid to spurt upward between the piston and the walls of the cylinder. Every particle throughout the compressed liquid has the same tendency of motion in every direction. If before compression of the liquid we place within it an empty glass bottle with a sealed stopper, it will then be found that sufficient pressure on the surrounding liquid will crush the sides of the bottle together, no matter in what position the

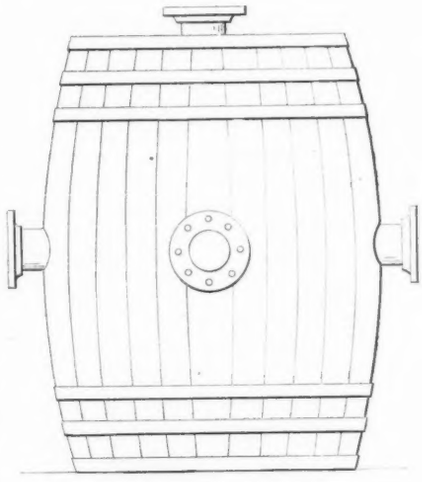


FIG. 3

bottle is placed within the compressed liquid.

From such considerations as these, Pascal, a celebrated physicist of the seventeenth century, deduced the following important principles:

"Pressure exerted in any given area of a fluid inclosed in a vessel is transmitted undiminished in all directions and acts with the same force on all equal surfaces and in direction at right angles to those surfaces."

Pascal's law can be illustrated in the following manner: Provide a tight barrel or cask with a number of openings around

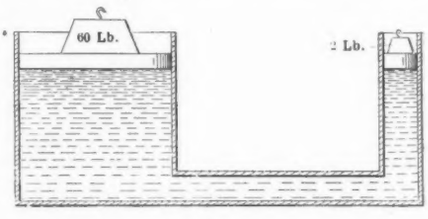


FIG. 4

the sides and one or more in the upper head. In each of these insert a nipple closed with a flange and rubber diaphragm, as shown in Fig. 2. Completely fill the barrel and nipple spaces with water and fit on the diaphragm in the head with

the nipple and flange filled to overflowing. The barrel and fittings will then resemble Fig. 3. Then a pressure by the hand downward on the upper diaphragm, or pressing any of the others inward, will cause all the other diaphragms to be bulged outward, assuming the position of the dotted lines in Fig. 2 and thus demonstrating the fact that no matter which diaphragm is pressed inward and no matter what may be the direction of pressure creating pressure on the liquid within the cask, an equal pressure is created in all directions, this being transmitted from any one diaphragm to all the others.

An approximate verification of Pascal's law may be effected by the experiment represented in Fig. 4. Two vertical cylinders of different diameters are joined by a tube and filled with water. On the surface of the liquid are pistons, large and small, which hermetically close the cylinders, but move without friction. Let the area of the larger piston be, for instance, thirty times that of the smaller one. That being assumed, let a weight, say of two pounds, be placed upon the smaller piston. This pressure will be transmitted to the water and to the large piston, and as this pressure amounts to two pounds on each portion of its surface equal to that of the small piston, the large piston is forced upward with thirty times as much pressure as the small one exerts downward; i.e.,

$$2 \times 30 = 60$$

pounds. So that if a weight of 60 pounds be placed upon the large piston both will remain in equilibrium. But if the weight on the large piston is slightly less than 60 pounds, equilibrium no longer exists and the pressure of two pounds on one piston causes it to descend and the other to ascend, the amont of ascent being equal to $\frac{1}{30}$ of the descent for the reason that the smaller piston has $\frac{1}{30}$ of the area of the larger and must therefore travel thirty times as far to create an equal displacement of water from the smaller to the larger cylinder.

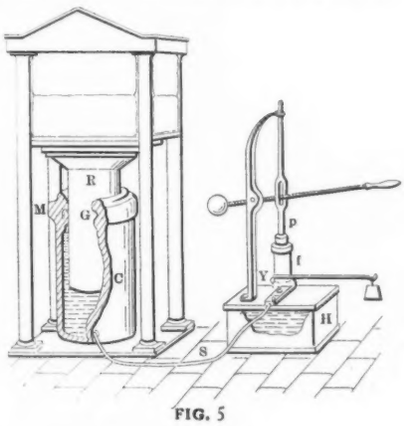


FIG. 5

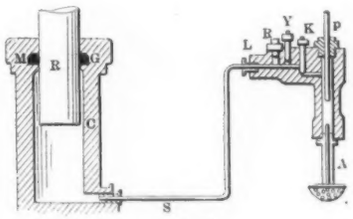


FIG. 6

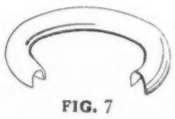


FIG. 7

Hydraulic Press as Proof of Pascal's Law

The hydraulic press furnishes one of the most convincing proofs of the truth of Pascal's law. Its principle is due to Pascal, but it was first constructed by Bramah in 1796, and consists of a strong cylinder *C*, Fig. 5, in which there is a cast-iron ram *R* working watertight in the collar of the cylinder. By means of a small pipe *S*, the cylinder *C*, which is filled with water, oil, glycerine or other liquid, communicates with a small force pump *f* worked by a hand lever or by power. Fig. 6 shows a section on a larger scale of the system of valves necessary in working the apparatus. The foot-valve below the plunger *p* opens when the plunger rises and closes when it descends. As the plunger rises a partial vacuum is produced in the suction pipe *A*, causing the liquid in the cistern *H* to rise in tube *A*, and when the plunger *p* descends, it drives the liquid through the pipe *S* into the large cylinder *C*. At *Y* is a safety-valve, held down by a weighted lever, which regulates the maximum degree of pressure, and *K* is a check-valve which prevents the pressure in the ram cylinder from returning to the pump; *L* is a screw relief-valve which permits liquid to escape from the ram and return to the cistern *H*.

One of the most important details of construction of a hydraulic press is the means taken to prevent leakage around the large ram, and until Bramah's invention of the collar packing, Fig. 7, the greatest difficulties had been experienced in making the ram work watertight when submitted to great pressures. Bramah's invention consists of a circular piece of stout leather saturated with oil, formed up in U-section and fitted in a groove *G* made in the neck of the cylinder, see Figs. 5 and 6. The collar is set concave downward, so that in proportion as the pressure increases, it fits tighter against the ram on the one side and the neck of the cylinder on the other. The pressure obtained from the press depends on the relative size of the ram *R* to the plunger *p*. If the ram has a traverse area one hundred times that of the pump plunger, then the upward pressure of the ram will be one hundred times the pressure applied to the pump plunger. The hydraulic press is employed in all cases where great pressures are required, such as in pressing oil from seeds, testing the strength of materials and raising great weights, the commonest example being the portable form of hydraulic jack.

Free Surface of a Liquid

The upper surface of a liquid contained in a vessel which receives no pressure, is called the free surface. In the atmosphere the upper surface of water is pressed downward by the air with a pressure of about 14.7 pounds to the square inch. The pressure of the atmosphere may be considered as transmitted through the water and its effect may be neglected, excepting in cases where a partial or complete vacuum is produced on one side of the body of water. In that case, the pressure of the atmosphere must be treated as a superimposed pressure.

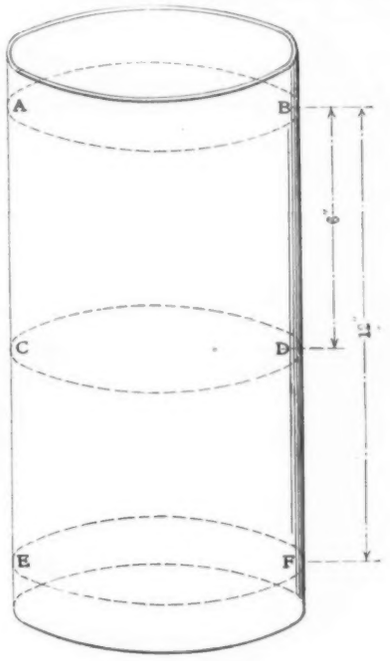


FIG. 8

Of small bodies of a perfect liquid the free surface may be considered as a horizontal plane, although the surface actually partakes of the curvature of the earth's surface, amounting to nearly eight inches in one mile and increasing as the square of the distance.

Head and Pressure Due to Gravity

Any depth below the free surface of a liquid is called a head; i. e., the head upon any point is its vertical depth below the level of the free surface.

A body of water or any other liquid in a condition of rest may be supposed to be made up of a series of horizontal

layers, each layer superimposing weight on all the layers below it. The force of gravity, therefore, produces internal pressure according to the depth or head, and following Pascal's law of equality of pressure, whatever may be the downward pressure on a particle due to the head upon it, the same pressure will be exerted in all directions. The vertical pressure due to head is made apparent by considering the action of gravity on a liquid

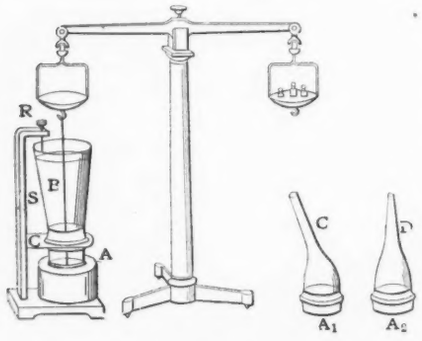


FIG. 9

contained in a vertical-side vessel, such as is shown in Fig. 8. Suppose the liquid to be made up of a succession of equal-depth, horizontal layers of water up to the level *A B*. It is evident that the pressure upon each layer due to gravity will depend upon the total depth of layers above it. Considering water as incompressible and therefore of uniform density, the first layer will press its entire weight upon the second, and the first and second upon the third and so on to the bottom of the vessel. Since the weights are all equal to each other, the pressure upon the succeeding layers will increase downward directly in proportion to the depth, so that any layer, as *E F*, under a head of 12 inches will be subjected to twice the pressure of a layer at *C D*, under a head of six inches.

The pressure exerted by a liquid on any portion of itself, or on the sides of the vessel in which it is contained, depends on the depth or head and on the density of the liquid, but it is independent of the shape of the vessel; and is also independent of the quantity of the liquid. The most direct method of demonstrating this principle is by means of an apparatus such as is illustrated in Fig. 9, in which *B* is a funnel-shaped vessel terminating in an open cylindrical end at *A* and supported by a collar or flange *C* secured to the stand *S*. A disk of cardboard covers the open bottom and is held in position by a thread passing up through *B* to one end of a scale beam. Water poured in the vessel *B* covers the cardboard bottom, and the total pressure is ascertained by placing the necessary counterpoise weights in the scale pan suspended on the other end of the balance beam. The hight of the water being observed and registered by the rod *R*, it will be found that the same weights will sustain the cardboard supporting the same depth of water in open-ended vessels like *C* and *D*, having the same size openings A_1 and A_2, regardless of the size or shape of the rest of the vessel.

It may readily be seen from consideration of these principles that a very small quantity of water may be raised up with sufficient head to produce an enormous pressure. Referring back to Fig. 3, let us suppose that the same barrel is provided with rubber diaphragms as before and that into the top of the barrel two lengths of ½-inch iron pipe are screwed, making a total hight of column of 30 feet. If now the stand-pipe and barrel of Fig. 10 are filled with water, the same pressure will be brought on the liquid in the barrel as though the barrel were extended full-size upward to the same hight as the ½-inch pipe. The pressure may be made as great as desired by merely extending the hight of the tube. Using a fine tube 40 feet high, Pascal succeeded in bursting a solidly constructed cask.

Pressure on the Sides of Vessels

According to the general law of the transmission of fluid pressure, the pressure caused by gravity at any point is transmitted in every direction. It, therefore, follows that at every point in the side of a vessel the liquid pressure will

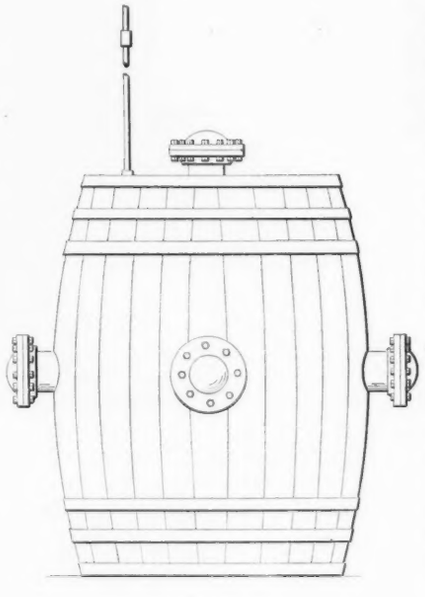


FIG. 10

be exerted at right angles to the side; that the degree of pressure will depend upon the depth or head creating the pressure, and the total amount of pressure will depend upon the area of the vessel exposed to the pressure.

Hydrostatic Paradox

The total pressure on the bottom of a vessel should not be confused with the pressure which the vessel exerts on the body which supports it. The pressure which is exerted on the supporting body will be equal to the combined weight of the liquid and the vessel, according to the form of the vessel. This fact is usually termed the hydrostatic paradox, because at first sight it appears paradoxical.

The pressure which the liquid exerts may be either greater or less than this combined weight. In case of a vessel

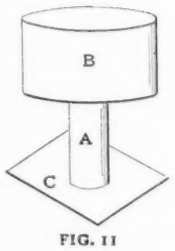


FIG. 11

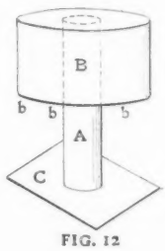


FIG. 12

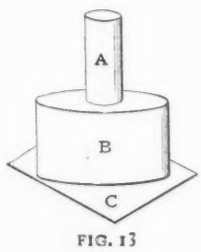


FIG. 13

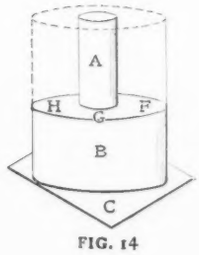


FIG. 14

shaped like that shown in Fig. 11, the pressure will be less than the combined weight, because the pressure exerted by the liquid at the foot of the smaller part *A* will be the same as though the whole amount of liquid consisted of only a column the size of *A* having the same hight of liquid as shown by the dotted lines in Fig. 12. The additional liquid surrounding this column and contained in the enlarged portion *B* is supported on the annular bottom *b b b*, which, in turn, is supported by the sides of *A* resting on *C*.

If, on the other hand, the shape of the vessel were inverted, i.e., like Fig. 13, with the enlarged part *B* at the bottom, then the total pressure on the bottom would be the same as though the whole amount of liquid consisted of a column the size of the enlarged portion *B*, as shown by the dotted lines in Fig. 14. In that case, the upward vertical pressure of a circular liquid layer *H G F* would be balanced by the weight of the liquid above acting downward. But if there is no such downward-acting liquid, the upward pressure is resisted by the annular head *b b b* and this upward pressure tends to lift the sides of *B* with the very same force that a vertical liquid column the full size of *B* would exert downward on the circular liquid layer *H G F*.

Where bolts are subject to rust, the threads should be painted with pure white lead; then they will not rust fast.

The Machinery Club of New York

A New Center for Machinery Men with Commanding Views of the City and Harbor and Complete Facilities for Refreshing the Inner Man

BY FRED H. COLVIN

The opening of the Machinery Club last May was quite an event in the machinery trade of the East if not of the whole country, as it forms a meeting place for all who are interested in this line. The idea originated with F. H. Stillman, president of the Watson-Stillman Company, who, on April 4, 1907, called a meeting which was the beginning of this club. It now numbers in the neighborhood of 1100 members about half of whom are local and the remainder are divided among 127 cities, including those in Mexico, Cuba, Japan and European countries, and a large number of applications for membership are on file.

A unique feature of the club is that the organization can elect no honorary members, the honorary class being limited to the President of the United States, the Governor of the State of New York, the Mayor of New York City and the Major-General commanding the Department of the East, together with the Commandant of the Brooklyn Navy Yard. Another feature, in the grill room, is a large round table which is known as the "open table," where out-of-town members and others who have but a limited acquaintance in New York get together, as it is a rule that diners at this table may engage in conversation without the formality of an introduction.

FIG. 1. THE BUILDINGS FROM THE RIVER. THE MACHINERY CLUB OCCUPIES THE TWO UPPER FLOORS OF THE BUILDING AT THE LEFT

The club occupies the two upper floors of the Fulton building, which forms part of the newly completed Hudson Terminal buildings located between Church and Greenwich streets and extending from Fulton to Cortlandt streets. This will be the terminal of the Hudson River tunnels connecting New York City and Jersey City and it is the plan of machinery dealers and firms having offices in New York to concentrate in this building both for the purpose of being convenient to the new club and also to be able to take customers to their warerooms in Jersey City in the shortest possible time, by using the new tunnels as soon as they are completed.

Fig. 1 shows the buildings as seen from the river. The building occupied by the club is the one on the left of the picture, the club rooms being on the twenty-first and twenty-second, that is, the top and next to the top, floors. The roof-garden restaurant, which forms a unique feature, is between the two small towers.

The stranger in New York will be most impressed by the commanding view which he secures in any direction and particularly from the roof garden, which will be utilized for a dining room whenever weather permits. This overlooks the North river with its ever-changing panorama of shipping, from the commonplace tug and ferry boats, to the latest of the ocean greyhounds, and, on a clear day visitors see where the Narrows lead out to the ocean and as far up as the beginning of the Palisades on the Hudson, while in the distance the mountains of New Jersey loom into view.

Fig. 2 is such a view from the roof garden looking southwest over the Hudson river and upper harbor. In the extreme distance at the left is Staten island, with Bartholdi's Liberty in the middle distance to the left of the new West building. Architecturally considered, this is one of the most successful of the sky-scrapers when viewed from its river side. In the immediate foreground are the chimneys of the New York Steam Company, the location of the camera being well above their tops. Immediately opposite and to the right of the picture is Jersey City, the arched roof of the Pennsylvania railroad terminal being barely visible. This building is also the Jersey City terminal of the tunnel of which the New York terminal is below the ob-

FIG. 2. LOOKING TOWARD JERSEY CITY

FIG. 3. OVER THE HUDSON TO THE JERSEY HILLS

server's feet. Immediately to the left of the Pennsylvania terminal is the Colgate building with its 40-foot diameter clock dial, of which much has been published lately, but which does not come out in the picture.

Fig. 3 is from the same viewpoint looking northwest over the river and down on surrounding buildings, and the elevated railroad. It includes shipping from the American liner at the left to the "Lusitania" at the extreme right, with one of the Sound steamers in the center. Almost in the center of the picture on the New Jersey shore, and scarcely discernible through the haze is the Lackawanna railroad terminal—the terminal also of a second pair of tunnels under the river which are now in commission—and just beyond are the docks of the North German Lloyd and the Hamburg-American steamship companies.

Perhaps an even more striking view is shown in Fig. 4, taken from the opposite side of the building and looking northeast. In the foreground we are looking down on the spire of St. Paul's church, noted as having had Washington as an attendant, as the burial place of Captain Lawrence of the ill-fated "Chesapeake," and of many other celebrities. To the left, in the form of a hollow square, is the old-time Astor House and just beyond it is the busiest post office in the world, while back of the church spire is the Park Row building with its two small towers

FIG. 4. LOOKING DOWN ON THE SPIRE OF ST. PAUL'S

FIG. 5. THE RECEPTION ROOM WITH WRITING DESK AND CURRENT PAPERS

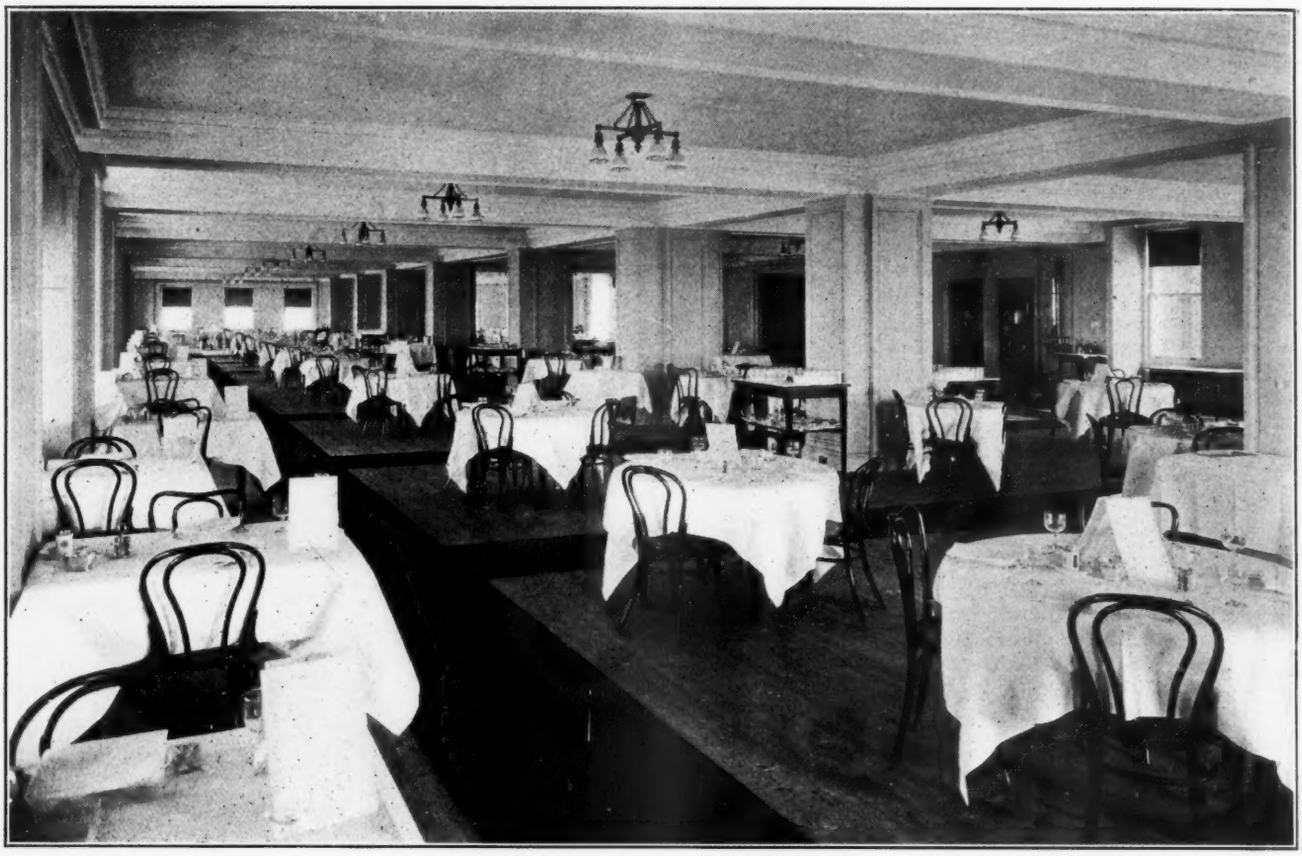


FIG. 6. THE MAIN DINING ROOM 50X150 FEET

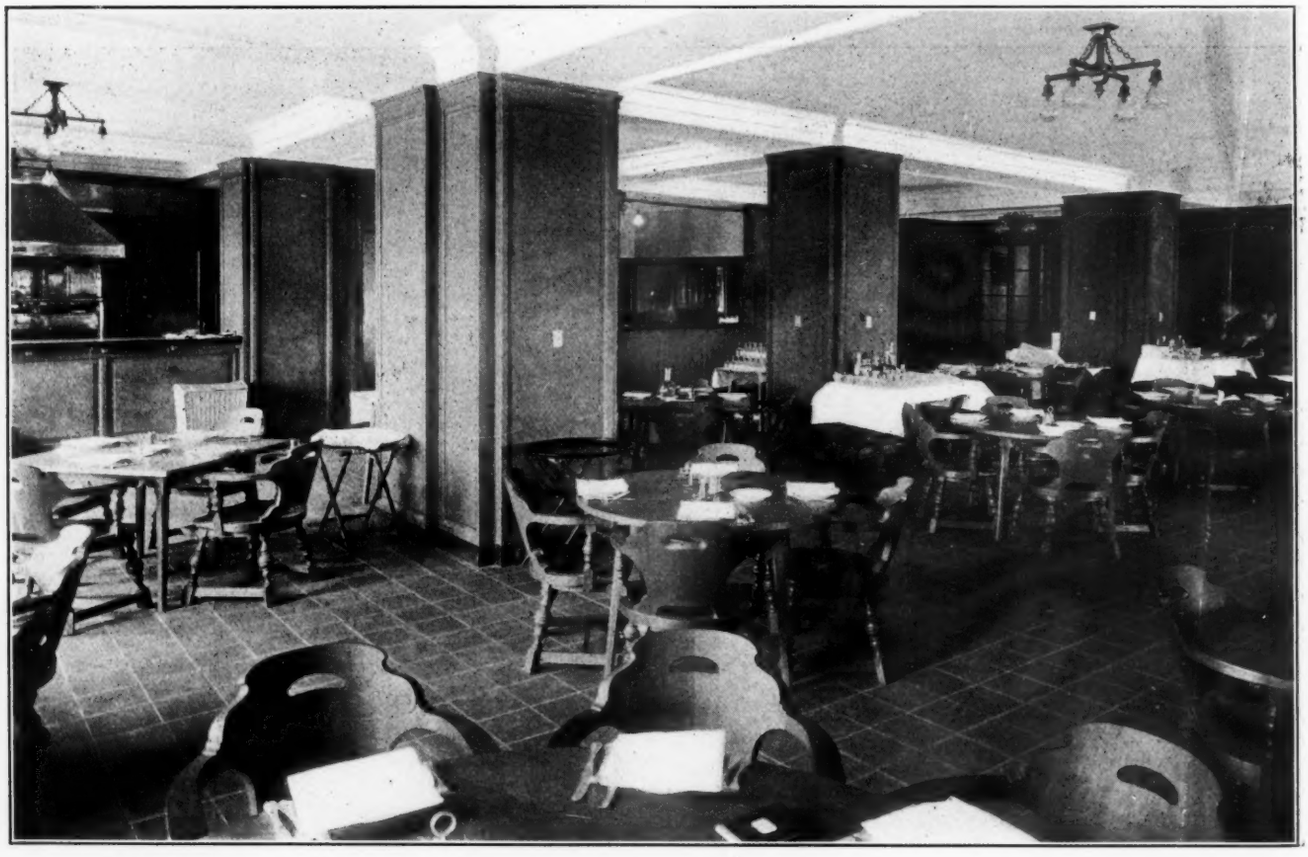
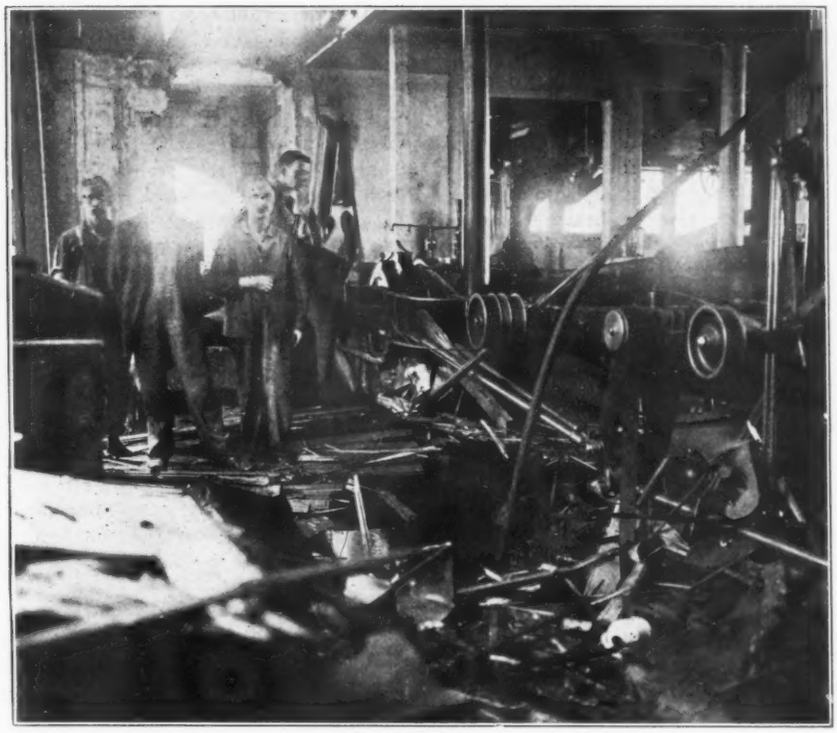


FIG. 7. THE GRILL ROOM WITH PART OF THE "OPEN" TABLE IN THE FOREGROUND



FLYWHEEL ACCIDENT AT RIVERPOINT, R. I.

which was the highest building until the Singer tower snatched away its laurels.

At the extreme right of the picture and in the distance is the Brooklyn bridge, at the left of which may be seen one of the towers of the Manhattan bridge now in process of erection. The Williamsburg bridge is directly behind the Park Row building, and at the extreme left and beyond the limit of the picture is the great Blackwell's island cantilever, which, while practically complete, is not yet in commission. Between the post office and the Park Row building is Park row, with the subway below its surface and rounding into Broadway, where the two streets join just beyond the church. This view gives an extremely good idea of the hight of the Machinery Club rooms and this insures at all times good light and air, as well as freedom from annoyance of noise, dust and flies. The main skyscraper district begins immediately at the right or south of this picture, and striking as it is from many points of view, its latest structure, the City Investing building, stands in a position to obscure most of the others from any point that can be obtained from the club's quarters.

The club rooms include all modern conveniences, such as private dining rooms, ladies' dining room, reception and smoking rooms, bath room, barber shop, etc. The grill room is shown in Fig. 5, part of the "open" table being in the foreground. The furnishings are of Mexican mahogany, the floor is tile and everything excepting the gear on the menu card is in strict accordance with mechanical ideas.

An idea of the extent of the main dining room can be had from Fig. 6, and here, as in the other views, can be noted the neat effect of the plain columns and girders. While this strikes one as being severe at a first glance, it is a decided relief from the usual attempt at ornate architecture and should be pleasing to all those who dislike seeing our forests denuded for ornamentation without useful purpose. Fig. 7 gives an idea of the reception room, in which there are conveniences for writing and where the various technical papers, as well as dailies, can be consulted.

We believe the club is destined to become very popular with machinery men from all over the world, and Mr. Stillman is to be congratulated on the successful carrying out of his plan.

The Flywheel Wreck at Riverpoint

The accompanying photograph shows part of the damage caused by the flywheel wreck at the Royal mills, Riverpoint, R. I., the particulars of which were published in the July 21 number. We are indebted to William H. Boehm, of the Fidelity and Casualty Company, for the use of the photograph.

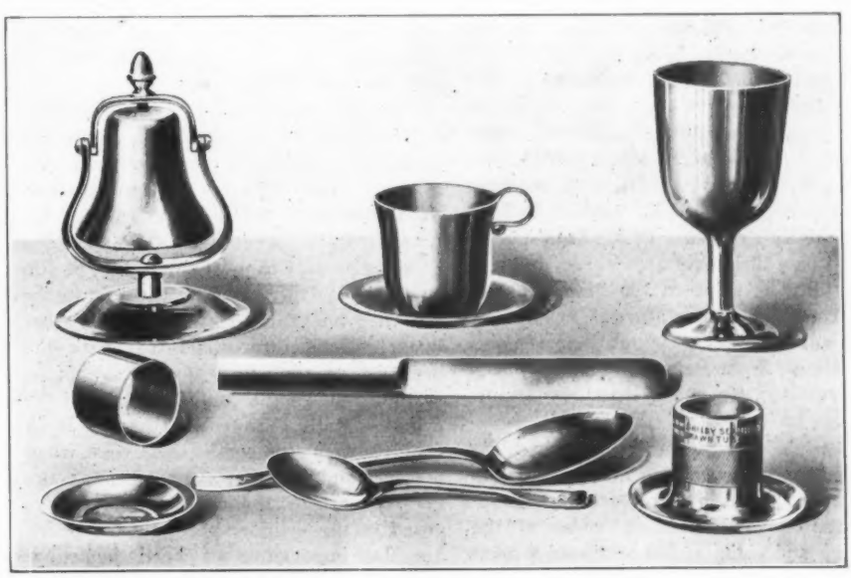
A New Use for Shelby Tubing

The tableware in the accompanying illustration formed part of a large dinner set, the pieces of which were formed of Shelby seamless steel tubing and were used at a banquet given to the officials of the National Tube Company. The chief purpose of the display is to direct attention to the adaptability of the Shelby product. The dishes were formed, not cast, from the tubing, and it may be noted that the material may be hammered flat, as shown by the knife blade and spoon handle; curved in or out, as in the plate or spoon bowl; left in its original form, as in the napkin ring; expanded at one end to several times its original diameter, as in the goblet; or formed into a bell.

Why a Compressor Cylinder Must be Water Jacketed

By Lucius I. Wightman

When a volume of air or gas is compressed from a lower to a higher pressure, all the work done upon that volume is converted into heat. This is the result of an increased activity imparted by the compression to the molecules composing the air or gas, but the process by which this activity, appearing as sensible



DISHES MADE FROM SHELBY SEAMLESS STEEL TUBING

heat, is produced need not enter into this discussion.

In the modern compressor, water jackets are provided surrounding the compressor cylinder for the purpose of carrying away, so far as may be, this heat of compression. In other words, power is expended in producing heat, which is then carried away by the cooling water without any useful effect. The compression process produces heat and pressure; the jackets carry away the heat, leaving only the pressure to show for the energy expended. Why not retain both the heat and the pressure, thus securing more nearly the full equivalent of the power used? The object of this paper is to explain this apparent anomaly.

The compression of air or gas must raise its temperature, whether the process be slow or fast. But raising the temperature of air produces one of two results. If the air volume is confined in a limited space, an increased temperature results in an increased pressure, due to the expansion of the air. If the volume is not confined, the increased temperature produces an increased volume, again due to expansion.

Assume that we have a compressing cylinder with a cross-section of 1 square foot and a piston travel of 6 feet, thus giving a cylinder volume of 6 cubic feet. Let this cylinder be filled with air at sea-level, atmospheric pressure 14.7 pounds, and at 60 degrees Fahrenheit. If the piston is now advanced for one-half its stroke, or 3 feet, this volume will be compressed to one-half its former volume, or we will have two volumes in the space of one, giving, at first glance, a pressure twice as great, or 29.4 pounds. If we continue to advance the piston until it has traveled 5 feet, we will have crowded our original volume of 6 cubic feet into a space of 1 cubic foot, and we should have a pressure of six atmospheres, or 73.5 pounds, gage.

As a matter of fact, in the latter case we will have a higher pressure than 73.5 pounds, the excess being due to the heat produced in the air in compressing it from one atmosphere to six. Just what this final pressure would be cannot be stated exactly. If our cylinder and piston were so made that not a particle of the heat could escape from the air volume, its temperature at a pressure of six atmospheres would be a little over 419 degrees Fahrenheit. But as some of the heat is bound to escape, this temperature is never fully attained. However, enough heat remains to increase the pressure, at the end of six compressions, to more than six atmospheres.

It would thus seem that we had expended more power than necessary, if six atmospheres was the pressure we set out to attain. The combined effect of the heating and compression produced a pressure of six atmospheres before the piston had traveled five-sixths of its stroke, and if the discharge valves were arranged to open at just that point, we could have saved the power required to produce this excess pressure.

The difficulty is that the pressure, which is the combined result of compression and heating, is not a stable pressure. The heated air, discharged at six atmospheres, rapidly cools or loses its heat by conduction and radiation. Now the cooling of a volume of air in a limited space reduces its pressure, just as heating it increases its pressure. The heated air at six atmospheres rapidly cools and its pressure drops, so that while we have compressed to six atmospheres in the cylinder, we actually have a pressure less than this in the pipe line available for work.

To produce a stable effective pressure of six atmospheres in the pipe lines, we must carry the cylinder pressure higher than six atmospheres, so that after the compressed air has cooled to the temperature of its surroundings, it will have the final pressure we set out to attain at our working tool. The difference between the six atmospheres on the line and the higher pressure in the cylinder represents an expenditure of power without useful effect, due to the heat of compression which was allowed to remain in the air during compression.

Result when Air is Cooled

Now, what would have been the result if we had arranged to cool the air during compression? Suppose we had made the walls and heads of the cylinder double, circulating cold water in this space, moving the piston forward very slowly and giving the water time to absorb and carry away all the heat of compression as fast as it is produced. There would be no excess pressure due to heating; the reduction of the volume from 6 cubic feet to 1 would produce exactly six atmospheres of pressure, and the air at this pressure would be in a stable condition. Thus the use of the water in this case would actually have saved us the power otherwise required to produce the higher but ineffective and useless pressure.

But, as a matter of fact, the condition just outlined is impossible of attainment in actual practice. Every-day results are a compromise between the two systems of compression which have been discussed.

A compressor cannot, in practice, be run so slowly as to permit all the heat to be absorbed and carried away by the jacket water. Temperature increases with the pressure, while the advancing piston steadily reduces the cooling surface of the cylinder walls with which the air is in contact. Near the end of the stroke, when pressure and temperatures are highest, the greater part of the cooling surface exposed is the cylinder-head, thus explaining the importance of head jacketing. Heat is conducted from one particle of air to another very slowly, so that after all, the interior of the air volume is not cooled by the jacket, but only that external film in contact with the cool cylinder walls.

All things considered, therefore, water jacketing a compressor cylinder results in only a part of the saving of power which in theory it promises. Some beneficial effect along this line it certainly has, particularly in long stroke, slow-speed machines. But the full benefit of cooling during compression can be secured only by other means—by the breaking up of the compression process into several intervals, between which the air is cooled by external means.

Cylinder jacketing is nevertheless essential in the modern air or gas compressor. Aside from the economical consideration just explained, it has other important effects on the proper operation, and indeed on the economy of the compressor.

The Effect upon Lubrication

Not the least important of these is its effect upon the lubrication. The compression of air from sea-level pressure and a temperature of 60 degrees Fahrenheit to six atmospheres, or 73.5 pounds, produces, unless some cooling is provided, a temperature of about 419 degrees Fahrenheit, as already stated. Such a temperature as this is destructive of all ordinary lubricants and packings, and the result would be a rapid wear of the piston, cylinder and valves, with inevitable leakage, loss of capacity, increased friction and excess power consumption. The water jacket keeps these parts reasonably cool, resulting in free lubrication, little wear, easy running and sustained efficiency.

An attempt to run continuously without jackets would heat the cylinder, valves, rods and other parts to such a degree that dangerous expansion stresses might be produced, resulting in distortion, added friction and possible breakage. The alternate expansion and contraction between the extreme temperatures of operation and shut-down would make it practically impossible to keep tight joints.

It is just as essential that air should be admitted cool to the cylinder, as that it shall be kept cool during compression. For cool air is dense air, and the cooler the air admitted, the greater in proportion the volume of compressed air delivered. The heating of cylinder walls, piston, rod, valves and ports means that the air entering the cylinder will be heated by them —first, while entering through the valves and ports, and second, by contact with the interior of the cylinder. This means lowered efficiency of the compressor and reduced capacity; and, since jacketing at best is only partially successful, this fact suggests the advantage of those constructions admitting air in a large body through one or a few large openings, rather than through a large number of small valves.

Inquiries

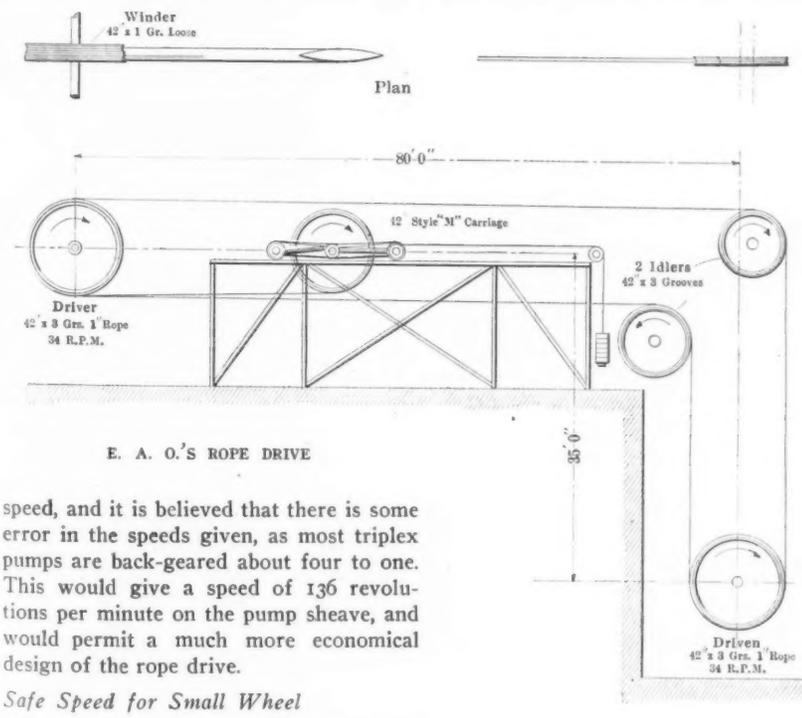
Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.

Triplex Pump Drive

I am about to change from belt to rope transmission a triplex power pump, the plunger of which is 7 inches in diameter, its stroke 8 inches, and which runs at 34 revolutions per minute, with an average coil pressure of 50 pounds per square inch, the present suction lift being 25 feet 6 inches. I wish to move the pump straight out from the main shaft and drop it into the well 20 feet, which will make 35 feet of drop. What size rope, hemp or iron, should I use, and which is best? When pulleys have more than one sheave should each rope run in its own sheave, or should it be one continuous rope running in all sheaves? How many sheave pulleys would I need besides the main and pump pulleys? Should the tightening pulley be stationary, or weighted, and at about what point?

E. A. O.

The accompanying sketch shows one design made from the information given. It is believed that this sketch will answer all the questions asked. The conditions are not deemed favorable for either belt or rope drive, on account of the slow



E. A. O.'S ROPE DRIVE

speed, and it is believed that there is some error in the speeds given, as most triplex pumps are back-geared about four to one. This would give a speed of 136 revolutions per minute on the pump sheave, and would permit a much more economical design of the rope drive.

Safe Speed for Small Wheel

I wish to run a cast-iron fly-wheel, such as is shown by the sketch, at 1300 revolutions per minute. Will it be safe at that speed? The estimated weight of the rim is 56.34 pounds; of the hub, 31.46 pounds; of the web, 28.32 pounds; total, 116.12 pounds. The mean rim velocity is 7475 feet per minute, or 124.58 feet per second.

W. T.

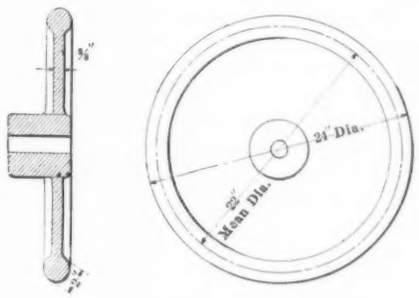
Considering the rim alone, the stress due to centrifugal force is expressed by the formula,

$$S = \frac{V^2}{10},$$

where

S = Stress,
V = Speed per second.

The rim velocity in this case is approxi-



DETAILS OF SMALL WHEEL

mately 125 feet per second, and V^2 would equal 15,625. Substituting in the formula we have:

$$Stress = \frac{15{,}625}{10},$$

or 1562.5. Taking 14,000 pounds as the strength of cast iron, it appears that the rim of the wheel would have a factor of safety of about 9, as the web supports the rim at all points, it would be considered safe at the speed named, if it is a sound casting.

Diameter and Length of Stack, Size of Valve Ports, etc.

(a) What should be the proportionate diameter and length of stack for boilers of different horse-powers? (b) What should be the length and width of valve ports for cylinders of different diameters? (c) How do you determine what size of pump to install for boilers of different horse-powers?

J. C. S.

(a) A stack should have an area equal to from 1/9 to 1/7 of the grate area, and a hight 20 to 25 times its diameter.

(b) To get the proper area of the steam ports of an engine, multiply the area of the piston in square inches by the piston speed and divide by 6000. The area divided by the length will give the width. The length should be about 9/10 of the cylinder diameter.

(c) A boiler feed pump should be of a size that will easily deliver four gallons per hour for each boiler horse-power.

Compression Valves

Are the compression valves on the steam end of a steam pump always placed in the steam port? Do you turn live steam into the cylinder of the pump for the piston to cushion against? When the pump is running high speed is there any bypass from the steam chest to the steam port? The makers say close these valves when running at high speed.

G. H.

Steam-pump cylinders usually have two ports at each end, termed steam and exhaust ports, respectively. The exhaust port is always covered by the slide valve and has communication with the steam port through a cored passage and a drilled hole which is covered by the compression valve. When the piston approaches the end of the stroke, it runs over the exhaust port and "pockets" a part of the exhaust steam in the cylinder and steam port. With the compression valve open, this steam escapes through the cored passage and the drilled hole into the exhaust port. With the cushion valve closed, there is no escape for the exhaust steam after the piston has covered the exhaust port, and the pocketed steam forms a cushion which prevents the piston from striking the cylinder head. Live steam cannot escape through the exhaust port when the valve admits steam to the steam port, because at this time one end of the exhaust port is covered by the valve and the other by the piston. When running light and fast, the compression valves should be nearly or quite closed, but with a heavy load and slow movement they should be wide open.

Weight of Water

What is the weight of a cubic foot of water at 212 degrees Fahrenheit?

F. H.

There is a little uncertainty about the exact weight of water at 212 degrees. The weights given by different writers vary from 59.56 to 59.84 pounds per cubic foot, with an average of 59.77 pounds.

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

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The Real Operating Cost of the Isolated Plant

In the matter of a fair determination of the cost of running isolated plants, the General Committee of the subordinate associations of the National Association of Stationary Engineers of Manhattan and the Bronx is doing a good work. This committee is made up of four delegates and four alternates from each of the ten associations in the city, and its duty is to look after educational work. About four years ago the committee purchased a complete line of apparatus suitable for power-plant testing and is prepared at any time to make a thorough test of any plant operated by a member of the association.

If at any time it is intimated to the proprietor that power, light or heat can be purchased more cheaply than it can be made on the premises, the engineer is in the position, if he does not already know, to find out for a certainty just what it is costing to operate every department under his care. From the results of the tests made by the committee the engineer may compile a tabulated statement which may be submitted to the owner for comparison with the estimates of the solicitor from the central station.

Surface Condensers

The demand for concentration, for high-speed express service, for the greatest rendition per dollar invested, per cubic foot of space occupied and per pound of weight carried, has brought to bear upon the design of the surface condenser some of the study, thought and experiment which have been expended upon the other factors of the power plant. For a long time nothing more, as Mr. Orrok says upon another page, than a "box full of tubes," with a flood of water following what happened to be the path of least resistance, with tubes subjected upon the steam side to a shower of water of condensation, keeping the steam from contact, and with pockets and quiet corners for steam and air and water, with an air-pump large enough for whatever happened and little attention paid to the getting of the air into it, the surface condenser has satisfied the moderate demands of the past, and awaited the demands created by the turbine and the strenuous central station man for scientific treatment along rational lines.

In a condenser taking care of 200,000 pounds of steam per hour, over 55 pounds of water are made upon the tubes per second. If this has to drip down over the bank below the point at which it is formed it can readily be seen that the lower tubes are going to be busy cooling off feed-water instead of condensing steam, and that the greater rate of condensation will occur upon the upper tubes. By arranging the tubes in banks, the condensation from each of which is quickly drawn to the side and disposed of, by leading the steam to a positive and rapid flow among these tubes in a direction counter to the flow of the water, so that the final contact of the condensed steam and air is with the coolest water, and by subdividing the flow so that the circulating water travels positively and rapidly past every square foot of the cooling surface, the condenser is made to condense eighteen or twenty instead of six pounds of steam per hour per square foot of surface. The significance of this, not only in first cost and space occupied, but in maintenance charges where, as in some of the large stations upon the Atlantic seaboard, tubes have to be renewed once in about three years, is easy to appreciate, and it is not the tube which is condensing lots of steam, but rather that which is loafing in an air pocket or an eddy, that is the most likely to corrode.

The Criminality of Operating Defective Apparatus

After all that has been said and published regarding accidents from frail, wornout or broken machinery, there is little excuse for the man who deliberately operates, or causes to be operated, apparatus which is known to be faulty. Several coils of wire rope which had done duty in elevator service in one of the large buildings in New York City had been removed. A casual glance showed nothing wrong, but a closer examination disclosed that the individual strands were badly worn, and in places broken. A freight elevator, which also carried passengers, was suspended by wire cables which were known to be in such condition that the broken ends of single-wire strands could be seen sticking out along the entire length of the rope. The engineer reported the matter to the owner, who took no steps to remedy matters other than to instruct the engineer to watch the cable a little more closely in the future. These two instances are cited to show that while in one case precautions were taken to guard against accident, the grossest negligence was practiced in the other.

When an engineer on a railroad has the misfortune to kill a man he is arrested for manslaughter. If a wreck occurs, both the engineer and conductor are arrested on a similar charge, even though the cause of the accident is entirely out of their control. It is seldom, however, that one hears of the arrest after an accident of persons guilty of operating faulty machinery, but is there any reason why such action should not be taken? If a man's conscience is so blunted that it will permit him to operate faulty machinery, the

failure of which may injure others, there should be a law carrying a penalty of such severity as to make a man think twice before he breaks it. This question can be discussed from every point, dealing with every phase of mechanical operation, and the facts will disclose that in every branch there are those who think more of the almighty dollar than of human life.

Two return-tubular boilers, owned by two separate companies, had been in operation about twenty-four years and were discarded as unsafe to operate at the desired pressure of sixty pounds. A small manufacturer (and doubtless a much smaller man) desired to purchase one of the boilers, and when told that it was unsafe to operate replied that he would risk it. The owner refused to sell him the condemned boiler. The would-be buyer then went to the other firm and purchased its condemned boiler for a song, both parties to this transaction evidently considering it of no consequence if the boiler did explode, as long as one received compensation for the boiler and the other got it "cheap." Will anybody dispute that such disregard for the safety of others is downright criminality?

Politics versus Civil Service

Competitive examinations for boiler inspectors, instead of appointment by the mayor, is the stand recently taken by the City of Detroit. This decision is expressed in an amendment to the ordinance passed January 14, 1896, giving the mayor the power of appointing the city boiler inspector, who, in turn, had the privilege of selecting his assistant. The term of office was three years, and in addition to performing his regular duties the inspector examined applicants for engineer licenses.

Politics, it is claimed, entered into these appointments to such an extent, and also into the issuing of licenses, that the system proved most unsatisfactory. It will be conceded without question that the office of boiler inspector requires a man of sound judgment and one who has had experience varied enough to make him thoroughly familiar with all phases of the work. Of such a man the proper selection cannot always be made offhand, especially if the selector is a man without knowledge of engineering subjects and does not appreciate fully the qualifications the position requires, or perhaps is influenced, to a greater or less degree, by what is included in the general term "politics."

Recognizing the defects of the system in force, and undoubtedly influenced to some extent by the general opinion of engineers in Detroit, the common council passed the amendment previously referred to and requested the dean of the engineering department of the University of Michigan to appoint an examining board. The request was complied with, and Prof. M. E. Cooley appointed a board, consisting of two consulting engineers and an insurance inspector, all residents of Detroit. Candidates were required to show ten years' experience in the care and operation of steam boilers and a residence of five years in the city.

In accordance with these limitations a written examination was held on June 5 to secure eligibles for the position of boiler inspector, and to facilitate the work the use of textbooks was allowed. Nineteen candidates were entered and the five attaining the highest percentage in this test were given an oral examination on June 12. The man passing highest in this examination was appointed chief inspector and the next highest, assistant inspector.

Since the appointments were made there has been considerable trouble in regard to the qualifications of the men selected. It is claimed that the chief inspector has not been a resident of Detroit for five years, and that his assistant has not had the necessary ten years' experience.

The point most worthy of note and for which the common council of Detroit is to be highly commended, is that the filling of so important and responsible a position as boiler inspector has been removed from politics and placed under the control of the State university's engineering department. That a fair and impartial examination is assured, there can be no question; nor can the engineering ability or integrity of the department be doubted.

The Value of Being Able to Talk Well

Something like two years ago an observing employer of both skilled and unskilled labor wrote, regarding engineers' service: "Most employers have but a poor conception of the work done in the engine room; and superior results, although involving marked economies, are even less often recognized and appreciated. Dealing with specific cases, the man who can best express himself is the one to be given the first hearing, other things being equal, and the greatest consideration."

It is seldom that so much that should be of real value to the engineer is stated in so few words. Facility of expression is frequently lacking in engineers who are otherwise among the ablest of their class. This lack is, much oftener than is known or even suspected, a serious handicap which, if the engineer desires or expects to advance in his vocation, should be removed. This he must attend to himself, and in no place can he do more in this direction than in the regular meetings of the association or society of which he should be an active member. Aside from the benefit technically derived, engineers' associations have an educating effect, which is hardly appreciated by more than a small percentage of the body. A visit to a business session of an engineers' organization will show, in a marked degree, the manner in which the engineer who has been chosen to represent his fellows in a delegated body understands the transaction of business in deliberative assemblies.

What the delegates practice in the convention every member should practice in the regular meetings of the subordinate associations. Here the member whose daily work is largely solitary comes in contact with his fellowmen, and if alive to his opportunities he will learn to express himself in a clear, businesslike manner that, with little practice, will become a useful habit. Then, when in consultation with an actual or prospective employer he will not appear at a disadvantage.

The opportunity of freely mingling with his fellows is one that should not be neglected by the engineer. The nature of his work is such that association with men of like interest is necessary to counteract the self-centering influence of his work. To be sure, engineers are human beings with tastes and desires like other men, but they seldom meet with other men in numbers except in association rooms or at conventions. These meetings are usually of a deliberative nature and have developed a class of men who can express themselves and their ideas with clearness and force, and not a few have become orators of no mean ability. These things, although regarded by some as accomplishments and parlor tricks, and are sneered at by others, have a broadening and educating influence on the men who have acquired them, and their attainment to some degree should be sought by all for the personal benefit to be derived from them. Conciseness and force of expression, logical deductions from plainly stated facts, and sound conclusions mark a man as master, and that above all other things the engineer should be. If in the past the engineers' associations have done nothing beyond the training along this line that has been given to a few, the associations have been well worth more than all that they have cost.

A 4000-horsepower steam engine of the double horizontal type at the central electric-generating station at Brussels, Belgium, has shown a consumption of 9.6 pounds of steam per indicated horsepower-hour with loadings from half to full load. The engine, which was built by the Van Den Kerchove Engine Company, of Ghent, has valves of the piston type, vertically arranged and operated from a lay shaft, and has 34½ and 60 by 60-inch cylinders. The ratio of areas of high-pressure to low-pressure cylinders is 1 to 2.97; the speed, 83 revolutions per minute, and the piston speed, 828 feet per minute.

Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

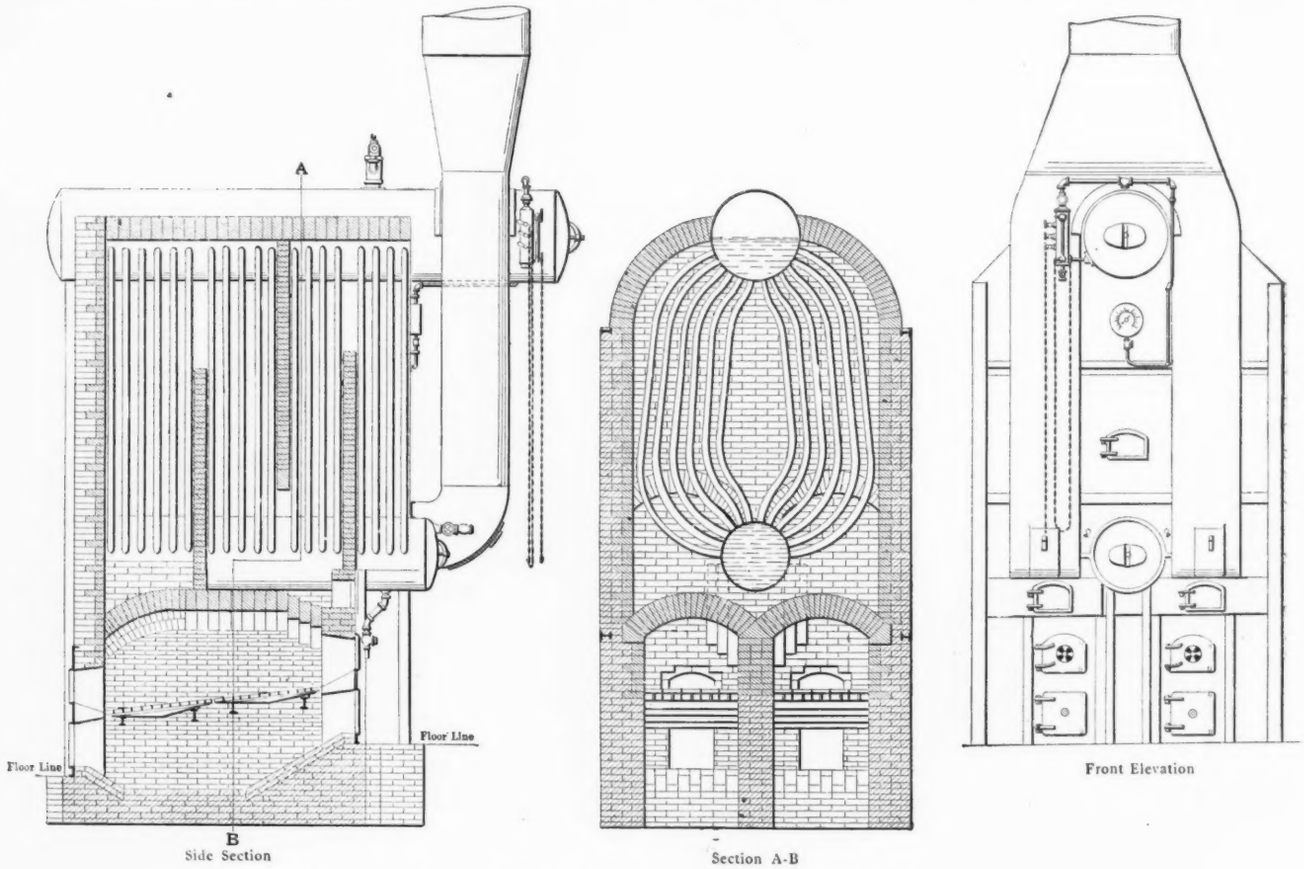
"Maxim" Water Tube Boiler

The "Maxim" water-tube boiler consists of two drums, one above the other, connected by tubes. Each tube has two bends, thus providing for unequal expansion and contraction. The space between the tubes is greater than the diameter of the tubes, so that any tube can be passed through the space between. The tubes, which are nearly vertical, are arranged in parallel rows, the lower tube plates being cylindrical, and the bottom end of every tube is opened to the lower drum, thus enabling the flue dust, mud and loose scale to drop away from the heating surface. There are no riveted joints exposed to the flames or fire gases, and there are no cylinders subject to external pressure.

The heating surface is arranged so as to break up the current of heated gases, which travels three times the length of the tube, the form and direction of the gas current being changed seven times between the furnace and chimney, to insure a low temperature to the escaping gases.

The circulation is constant, the return circulation being provided for by a third set of tubes, which are subjected to the heat of the gases just before reaching the chimney. As the cold feed water meets the gases as they leave the boiler, the front section of the tube, which receives the feed water, acts as an economizer and purifier.

The furnace of this type of boiler is constructed of fire-brick and is built under the boiler. Between the furnace and each combustion chamber there is a throat contracted to the proper size for drafts, the purpose being to ensure a better combustion by an intimate mixture of gases. The illustrations show a side view, sectional view through *A B* and a front view. This boiler is manufactured by the Maxim Company, 130 Fulton street, New York City.



THREE VIEWS OF THE MAXIM WATER-TUBE BOILER

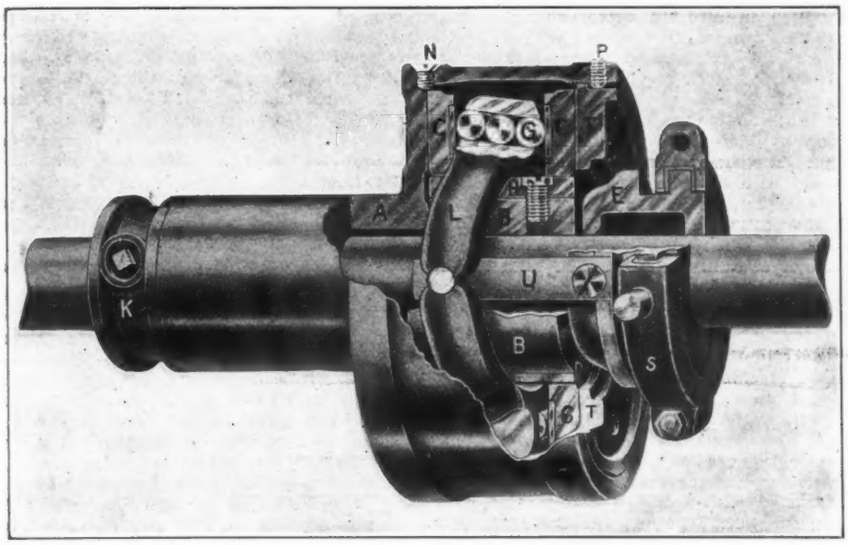
The "Akron" Friction Clutch

The "Akron" friction clutch is now being manufactured by the Williams Foundry and Machine Company, Akron, O. The sectional view shown gives a clear idea of its construction. The clutch consists of a drum *A* carrying a hub to which a pulley gear or sprocket may be keyed. The head *T* of the drum is separate, and the clutch is adjusted by screwing it into the drum *A* and securing it by means of the locking screw *P*.

Within the drum are arranged two iron friction disks *C*, which being keyed by *H* to the driving member *B* forces it to rotate with the shaft. The disks *C* are

free to move laterally on the keys *H*. The clutch depends for its power transmitting capacity upon the friction between the friction disks *C* and the corresponding friction surfaces of the drum *A* and cover *T*.

The clutch is engaged by forcing the friction disks *C* into contact with the drum heads by means of the toggle mechanism. The drum *A* is filled with oil,



SECTIONAL VIEW OF AKRON CLUTCH

into which the friction plates and operating mechanism dip, the oil being renewed by pouring it in at the oil hole *N*.

The toggle mechanism consists of two forked levers *L* with holes through them, in which are lodged three hardened and ground tool-steel rollers *G*. When the levers *L* are in a plane perpendicular to the shaft, the line of the centers of the three rollers is perpendicular to the faces

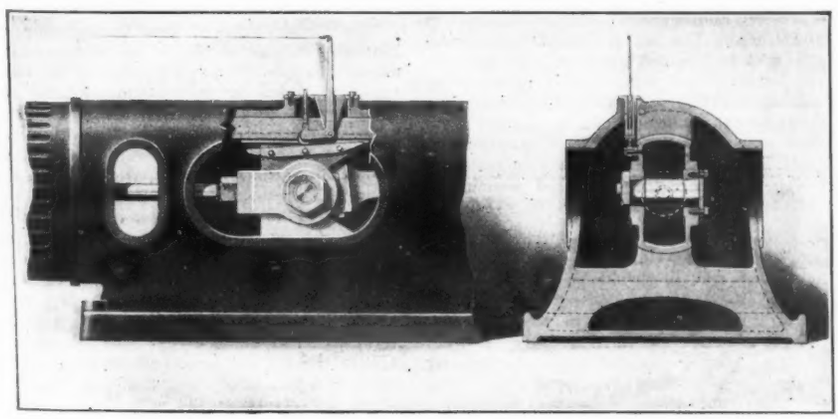


FIG. 1. AMERICAN-BALL REDUCING MOTION

of the friction disks and the latter are pressed into contact with the friction disks *C*. The wear of the rollers against the inside of the friction disks *C* is taken by hardened tool-steel disks set into their inner surfaces. The inner ends of the forked levers are connected by steel links to a sliding collar *E* by means of which the clutch is operated.

An Improved Indicator Reducing Motion

A new indicator-reducing motion has just been placed on the market by the American Engine Company, of Bound Brook, N. J., to be used on its engines. There is nothing to forbid its being used with any other type of engine, however.

In Fig. 1 the device is shown connected to the crosshead. It consists essentially in a slotted plate through which moves an L-shaped lever pivoted on a bolt. The short arm of the lever is forked. In the bifurcation a small wheel or roller is set. Connected with this arm is a pin which works through and at right angles to the outer plate. A helical spring pressing against the outer plate and a disk resting on the shoulder of the pin constantly tend to maintain the L arm at the extreme end of the slot. The device is fastened by bolts to the frame of the engine. Fig. 2 shows the device in detail.

On the crosshead is bolted a cast-iron cam plate or slide set on an angle in the vertical plane with the lower end directed away from the cylinder and at such an angle that the lower or front end is about 2 inches below the rear end, the angle of this cam plate being determined by the length of the stroke of the engine, so that the same difference in hight between the front and rear ends of the plate will be preserved in all cases. When the crosshead is in a position nearest the cylinder, the lower end of the cam plate or slide is in contact with the wheel at the lower end of the L arm, and as the crosshead travels forward, this wheel, with its arm, is raised in exact proportion to the piston travel against the pressure of the spring; the reverse taking place as the crosshead returns. It is said that the strength of the coiled spring is sufficient to prevent any lost motion with this device, even in a high-speed engine. It will furthermore appear that the adjustment of the cam plate can always be so arranged that the travel of the upper end of the L arm is exactly that desired to turn the indicator

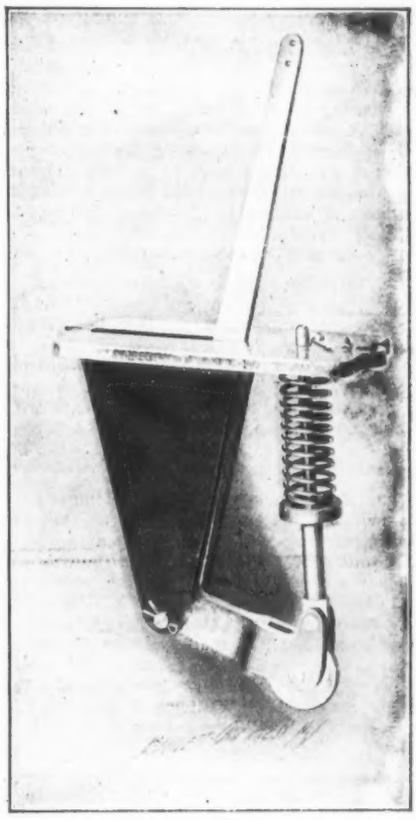


FIG. 2. SHOWING CONSTRUCTION OF REDUCING MOTION

cylinder the required distance without further reduction.

Referring to Fig. 2, it will be seen that on top of the exterior plate is a small flat trigger or lock which engages with a slot milled into the spindle working in and out through the plate. Thus, when the pin is

pushed to its extreme top position, the trigger can be slipped into the slot and the rig instantly thrown out of engagement. It is but the work of an instant to release the trigger and to throw the indicator rig into service.

The only visible part is a highly polished oblong metal plate on the engine frame, with a slot through which projects a 6- or 7-inch lever with a hole in the top. The indicator cord may be kept constantly attached to the lever, and the device thrown in and out of service as many times as desired.

Business Items

The Chapman Valve Manufacturing Company announces that hereafter its office and warehouse will be at 47 Terminal Way, South Side, Pittsburg, Penn., where a complete stock of Chapman valves will be kept on hand for immediate delivery.

The Minneapolis Steel and Machinery Company has just started work on another 300-horse-power Muenzel producer gas engine and gas producer for the Aberdeen Light and Power Company, Aberdeen, South Dakota. This company already has a 300-horse-power Muenzel plant, which has been in operation since last spring, and is now adding another unit to take care of the increasing load.

On Friday, July 24, the American District Steam Company, of Lockport, N. Y., suffered the loss by fire of a portion of its Tonawanda plant, where are located its casing mill and foundry. Plans are made for rebuilding the burned portion, on an enlarged scale, of as near fireproof construction as can be. The company informs us that its business for the season will not be delayed on account of the fire. The loss is fully covered by insurance.

A very attractive circular showing a handsome view of the residence of Charles P. Taft, of Cincinnati, brother of William Howard Taft, the Republican nominee, is being sent out by the Burt Manufacturing Company, of Akron, Ohio, which has equipped the above-mentioned residence with three 20-inch and one 24-inch Burt combination skylight ventilators, fitted with adjustable sliding-sleeve dampers.

The P. H. and F. M. Roots Company, of Connersville, Ind., has just issued a catalog of the Roots blower, which in addition to matter descriptive of the blowers, and illustrations of plants in which they are in use, contains a collection of charts and tables for determining the linear velocity of air through pipes necessary for a given flow, the flow of air through an orifice, the horsepower required by rotary blowers, the horsepower of an engine, and the power conveyed by belting. It may be had upon application.

The general offices of the American Stoker Company are now located in the Park building, Pittsburg, Penn. The company, in reorganizing its management, has installed as its chief engineer John Van Brunt, who has had several years' experience with the stoker problem, and having made very advantageous arrangements with the Coshocton Iron Company, which company is closely allied to the steel interests, the American company is prepared to execute promptly all orders for stokers or stoker repair parts, both chain-grate and American underfeed.

A C. H. Wheeler surface condenser has been installed at the new mill of the Megargee paper mills, Coatesville, Penn., in connection with a Westinghouse-Parsons steam-turbine installation. The condenser contains 2300 square feet of cooling surface. Circulating water is supplied by a centrifugal pump, direct-connected to an 8x9-inch marine-type engine; the air pump is an 8x16x12-inch Mullan horizontal crank and fly-wheel suction valveless type. The entire outfit is the product of the C. H. Wheeler Manufacturing Company, of Philadelphia. Recently, with an initial circulating water temperature of 74 degrees Fahrenheit, the condenser was maintaining a vacuum of 28½ inches.

The Du Bois Iron Works, of Du Bois, Penn., has been awarded the street lighting contract for the town of Du Bois. The system will require 125 arc lights, with provision for 25 additional arcs as required. The system will be operated entirely by gas engines of the twin tandem cylinder type, belted to General Electric Company's generators of the alternating-current type. The power plant will be equipped immediately with 300 horse-power, which will be increased later to 600 horse-power. A number of other sales of engines from 30 to 175 horse-power are also reported and the company says there is a gratifying increase in sales on the smaller sizes of gas and gasolene engines, also steam and power pumps, of which it builds many.

Owing to the increased demand for its product in the central and middle West, the Mesta Machine Company, of Pittsburg, has opened an office in Chicago at 844 Commercial National Bank building, from which point the company's business in rolling-mill machinery, gas and steam engines, condensers and machine-molded gears, steel castings, etc., will be taken care of by Lane Johnson. Mr. Johnson, who for some time has been connected with the Pittsburg office of the Mesta company, is a graduate of the Massachusetts Institute of Technology, and for five or six years previous to his accepting a position with the Mesta Machine Company was actively engaged in the iron and steel industry, holding for some time a prominent position with the Colorado Fuel and Iron Company.

The William B. Pierce Company, of Buffalo, N. Y., recently installed a Dean boiler tube cleaner in the state capitol at Albany for cleaning water-tube boilers. The award was given the William B. Pierce Company after a competitive test in which the Dean and several other tube cleaners were thoroughly tested as to efficiency, ease of operation and durability. The Clinton prison at Dannemora, another State institution, reports an interesting test of the Dean cleaner recently sent to the institution for trial, and as a result of that test has decided to purchase the cleaner. In this case, the cleaner removed several hundred pounds of scale from boilers supposed to be clean. It removed 160 pounds of scale from one boiler immediately after the insurance inspector had pronounced it a "clean boiler."

The Buckeye Boiler Skimmer Company, South End, Toledo, Ohio, put one of its boiler skimmers on trial in the boiler of the plant of H. Hanke, Elgin, Tex., and has received a letter from Mr. Hanke, in which he says: "I am convinced that the skimmer is O. K. It frees the boiler water of mud and sediments, thereby keeping down priming and producing dryer steam and a smoother-, swifter-running engine. I can say during low water in my pool the skimmer had a chance to show its value in the way of keeping down priming. Before I had the skimmer I sometimes encountered such trouble with boiler priming that the engine was running on water and steam when water in my pool was low. The skimmer has done away with that trouble; the engine has never run as smoothly as since I installed it. You left me the choice of returning to you the skimmer or sending the money for same. I prefer to keep the skimmer and send you the money, with thanks for the opportunity you have allowed me to give it a thorough trial."

The American Radiator Company has acquired through receiver's sale all the interests in the "Bundy" steam trap, formerly controlled by the A. A. Griffing Iron Company. The headquarters of the Bundy department of the American Radiator Company are at 104-8 West Forty-second street, New York City. D. J. Lewis, Jr., formerly with the A. A. Griffing Iron Company, and who developed the Bundy trap, will have full charge of this new department. Mr. Lewis states that the sale of traps will go on as hitherto. A. S. Mappett, former manager of the Philadelphia branch, continues in charge of the Bundy department in that city. John Sabin, former manager of the Boston branch of the old company, will continue as manager of the Bundy department of the new company. W. E. Van Kuesen formerly assistant to Mr. Lewis, will have charge of the New York territory. As a matter of fact, all the representatives of the old company throughout the country are still selling the Bundy trap and will continue to do so from the sales departments in all the leading cities.

The squealing commutator is a source of much annoyance even though it may be entirely free from sparking and arcing. The Joseph Dixon Crucible Company, of Jersey City, N. J., reports that its graphite brushes, which are made in only one quality, are giving most excellent satisfaction. The company frankly acknowledges in its literature that a one-quality brush is not adapted to all conditions, but it says that where its brushes are adapted they give unexcelled service. Their use results in the commutator taking on in a short time a highly polished surface, smooth and well-rounded. It is also stated that since the installation of the company's own electric plant, some eight years ago, it has not had occasion to turn down its commutators, and it reasonably attributes the condition of the commutators to the use of its graphite brushes. A concise little booklet of twelve pages is supplied to any and all who may be interested in commutation and who will write to the Dixon company for it. Some incidental hints in this booklet include information concerning the testing of brush pressure and the filing of mica insulation. There are also some conclusions as a result of tests made by Prof. Albert F. Ganz, of Steven's Institute of Technoogy.

The increasing use of small Curtis steam turbines is strikingly shown by an inspection of a partial list of turbines under 500 kilowatt capacity, which up to the present time have been installed by the General Electric Company, or are under construction. Of the 570-odd turbines listed, representing a total capacity of about 37,000 kilowatts, 7 per cent. are for the export trade. The remainder are intended for domestic service in central stations, marine work, laboratories of educational institutions, power and lighting plants for hotels and office buildings, laundries, mines, printing establishments and in every branch of manufacturing. It is interesting to note the widely different industries in which small Curtis steam turbines are used. Among the list are woodworking plants, foundries, iron and steel mills, distilleries, chemical plants, ice plants, textile mills, breweries, tanneries, flour mills, shoe factories, paper mills, machine shops, textile mills and ammunition-manufacturing plants. Turbines for train lighting are finding a ready market and it is interesting to note that the leading railroads are using this method of train illumination. The latest application of moderate-size Curtis turbines is for driving fire pumps, in which capacity they have been very satisfactory. On board ship, where a compact generating unit is required, small turbine lighting sets are also rapidly coming into favor.

The Original Indicator Improved

Base Your Operation On Accuracy

¶ Information about costs is essential to economical and efficient maintenance, but to be of value all information must be accurate and absolutely reliable.

¶ If, as is frequently the case, the fuel consumed in your plant is out of proportion to the power developed, your costs are running up—a leak exists—perhaps several. These should be stopped.

¶ To disclose faults of this nature a good indicator should be used, and the best is the **American-Thompson Improved.**

¶ The duty of the **American-Thompson Improved Indicator** is to tell you just how and where faults may be found. It is accurate—absolutely so, and it gives you diagrams which show conditions exactly as they are. It helps you to immediately locate all points of loss and permits you to save where otherwise you lose.

¶ Simplicity, reliability and durability mark its construction.

¶ When desired, each instrument is equipped with our **New Improved Detent Motion,** a patented attachment controlled solely by us. This attachment enables you to take 10 cards in the time usually required to take one. Cards may be taken in rapid succession and without the necessity of stopping or disconnecting drum cord from the drum carriage.

¶ If your jobber does not carry **"The American"** and will not procure them for you, we will ship to you direct from our factory.

Circular 2-B describing this instrument will prove interesting to you.

American Steam Gauge & Valve Mfg. Co.,

208-220 Camden Street, Boston, Mass.

New York, 26 Cortlandt St. Atlanta, 835 Equitable Bldg.
Chicago, 7-9 So. Jefferson St.
Pittsburg, Frick Bldg. Annex. San Francisco, 247 Pine Street.
Montreal, 444 St. James Street. Los Angeles, 213 So. Los Angeles Street.

When ordering gauges, valves, indicators and kindred appliances for governing, indicating, measuring, recording and controlling steam, air, gas, oil, ammonia and all other pressures, be sure to specify those manufactured by us. Your interests can be best served by the protection they afford.

New Equipment

The power plant at Syracuse University, Syracuse, N. Y., will be enlarged.

The Caraleigh Mills Company, Raleigh, N. C., will install electrical machinery.

The Pilot Cotton Mills Company, Raleigh, N. C., will install electrical machinery.

It is said the Nashville (Tenn.) Gas Company will expend about $350,000 in improvements.

The city of Starke, Fla., has voted $12,000 bonds to extend and improve electric-light plant and water works.

W. F. Turner, Atkins, Ark., has been granted a franchise to construct and operate an electric-light system.

The University of Georgia, Athens, Ga., has secured an appropriation of $15,000 for heating and lighting school.

The Great Western Power Company, Oakland, Cal., will erect a substation, to cost, when completed, about $150,000.

Frank B. Gilbreth, New York, has been awarded contract for a $1,000,000 cotton mill to be erected at Paterson, N. J.

The Gainesville, Whiteboro & Sherman Interurban Railway will erect a power house. John King, Gainesville, Texas, president.

Plans are being considered by the Wausau (Wis.) Street Railway Company for the construction of a new electric power station.

The Augusta (Ga.) Abattoir Company, recently incorporated, will erect buildings. A refrigerating plant will probably be installed.

The Lexington (Ky.) & Interurban Railway Company contemplates the erection of electric power plant. J. B. Crawford, general manager.

The Chanute (Kan.) Electric Railway Company will shortly commence construction work. Power station will be at Chanute. William Gray, president.

The Bliss Silk Throwing Company, of Dickson City, Penn., is said to be having plans prepared for erection of mill to replace present experimental plant at Alexandria, Va.

It is reported that bids will be received about August 15 by the Fremont (Ohio) Power and Light Company for the construction of power plant to cost about $200,000.

The Cherokee Oil Mill Company, Gaffney, S. C., has been incorporated with $20,000 capital. R. C. Sarratt, president. Building will be erected at once. Electric power will be used.

The Durham Cotton Manufacturing Company, East Durham, N. C., will install electric generators and motors to replace present equipment. About $50,000 will be expended in improvements.

The power station of the United Electric Light and Power Company on 146th street and Amsterdam avenue, New York, will be remodeled and enlarged. Improvements will cost about $18,000. W. E. McCoy, electrical engineer.

The Cincinnati, Dayton & Fort Wayne Railway Company is planning to commence construction of its proposed railway. Power stations will be located at Seven Mile and Celina, Ohio. S. T. George, Dayton, is president and general manager.

The Kansas-Colorado Railroad Company is said to be preparing for the construction of its electric railway systems from Canon City, Col., to Garden City, Kan., Power stations will be located at Canon City. S. H. Atwater, Canon City, president.

New Catalogs

H. Krantz Manufacturing Company, 160 Seventh street, Brooklyn, N. Y. Bulletin No. 21. Standard and water-tight boxes for electrical installation purposes. Illustrated, 50 pages, 6½x10 inches.

Diamond Machine Company, Providence, R. I. Catalog. Improved wet tool grinders. Illustrated, 16 pages, 6x9 inches. Catalog. American grinding attachments and center grinders. Illustrated, 20 pages, 6x9 inches.

General Electric Company, Schenectady, N. Y. Bulletin No. 4590. Self-starting devices for alternating current motors. Illustrated, 8 pages, 8x10½ inches. Bulletin No. 4593. Railway converter sub-stations. Illustrated, 24 pages, 8x10½ inches.

Schutte & Koerting Company, Philadelphia, Penn. Circular 8-C. Balanced stop and throttle valves. Illustrated, 24 pages, 8x11 inches. Circular 8-D. Balanced trip and trip-throttle valves. Illustrated, 24 pages, 8x11 inches.

General Electric Company, Schenectady, N. Y. Bulletin No. 4576. 4500-volt oil break switches. Illustrated, 18 pages, 8x10½ inches. Bulletin No. 4578. Railway motor controllers. Illustrated, 12 pages, 8x10½ inches. Bulletin No. 4584. The CQ motor. Illustrated, 16 pages, 8x10½ inches.

Crocker-Wheeler Company, Ampere, N. J. Bulletin No. 101. Form D machines, belt type direct current. Illustrated, 8 pages, 7½x10 inches. Bulletin No. 102. A. c. switchboard panels, type 12. Illustrated, 24 pages, 7½x10 inches. Bulletin No. 104. Direct current railway generators. Illustrated, 12 pages, 7½x10 inches.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

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ALL PRACTICAL ENGINEERS should apply to Wm. O. Webber, Consulting Engineer, 432 Exchange Bldg., Boston, for information concerning tables on all engineering subjects.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-Examiner U. S. Patent Office, 4 Dietz Bldg., Washington, D. C.

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FOR SALE—500 H.P. double Corliss engine, 250 H.P. each side, 23x26, slow speed. This engine is in excellent condition and can be had at a bargain. Address, Fall River Bleachery, Fall River, Mass.

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SUCCESSFUL OIL SEPARATION
PROOF OF EFFICIENCY

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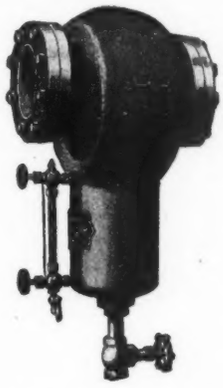

To show that the Cochrane Separator is a good one, let us quote from a report made some eight years ago by the chemist of one of the largest locomotive building concerns in the world upon a Cochrane Separator attached to and forming a part of the first of a number of Cochrane Feed Water Heaters supplied to that Company's shop for utilizing the exhaust of auxiliary machinery to heat the boiler feed: "The water was flowing freely, and therefore the sample should show the degree of separation of oil from the water in these heaters. Because of the very minute quantity of oil, the sample was agitated from time to time for two days with chloroform, which we thought would be the best solvent to use and it was allowed to evaporate below its boiling point to prevent possible loss of oil. Sample, 1.6 parts per million."

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Books, Technical

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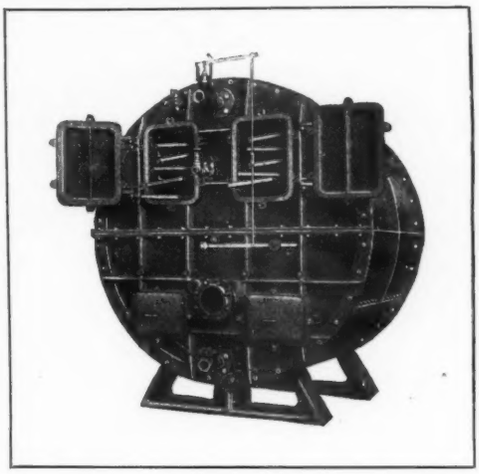
Hill Publishing Co., New York.
International Text Book Co., Scranton, Pa.



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Oster Mfg. Co., Cleveland, O.

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Draft, Mechanical

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General Electric Co., Schenectady, N. Y.
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Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

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Penberthy Injector Co., Detroit, Mich.

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Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Northern Electrical Mfg. Co., Madison, Wis.

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Ohio Brass Co., Mansfield, Ohio.

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Mound Tool & Scraper Co., St. Louis, Mo.

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Bates Machine Co., Joliet, Ill.
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Griffith & Wedge Co., Zanesville, O.
Ide & Son, A. L., Springfield, Ill.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
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Providence Eng. Works, Providence, R. I.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Watertown Engine Cc Watertown, N. Y.
Wetherill & Co., Robert, Chester, Pa.

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Buckeye Engine Co., Salem, Ohio.
De La Vergne Machine Co., New York.
Du Bois Iron Works, Du Bois, Pa.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Foos Gas Engine Co., Springfield, O.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Riverside Engine Co., Oil City, Pa.
Struthers-Wells Co., Warren, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

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American Engine Co., Bound Brook, N. J.
Ball Engine Co., Erie, Pa.
Bates Machine Co., Joliet, Ill.
Buckeye Engine Co., Salem, Ohio.
Clark Bros. Co., Belmont, N. Y.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Eng. Co., Fitchburg, Mass.
Ide & Son, A. L., Springfield, Ill.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Phoenix Iron Works, Meadville, Pa.
Reeves Engine Co., Trenton, N. J.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Machine Co., Philadelphia, Pa.
Watertown Engine Co., Watertown, N. Y.
Westinghouse Machine Co., Pittsburg, Pa.

Engines, Medium and Low Speed

Ball Engine Co., Erie, Pa.
Brown Engine Co., C. H., Fitchburg, Mass.
Buckeye Engine Co., Salem, Ohio.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Engine Co., Fitchburg, Mass.
Ide & Son, A. L., Springfield, Ill.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Reeves Engine Co., Trenton, N. J.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Mach. Co., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

Engines, Oil

American Diesel Engine Co., New York.
De La Vergne Machine Co., New York.

Engines, Rotary

Ball-Cooley Engineering Co., New York.

Exhaust Heads

Burt Mfg. Co., Akron, O.
Gardner Gov. & Separator Co., Quincy, Ill.
Hoppes Mfg. Co., Springfield, O.
Ohio Blower Co., Cleveland, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

Fans, Electric

Ft. Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Triumph Electric Co., Cincinnati, O.
Westinghouse Elec. and Mfg. Co., Pittsburg, Pa.

Fans, Exhaust and Ventilating

Ohio Blower Co., Cleveland, O.
Sirocco Engineering Co., New York.

Fans, Mine Vetilating

Jeffrey Mfg. Co., Columbus, O.

Feed Water Filters

Beggs & Co., Jas., New York.
Eclipse Feed Water Heater and Purifier Co., Appleton, Wis.
Keystone Chemical Co., Philadelphia, Pa.
Northern Water Softener Co., Madison, Wis.

Feed Water Heaters and Purifiers

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Kewanee Boiler Co., Kewanee, Ill.
Loew Mfg. Co., Cleveland, O.
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Wheeler Condenser and Engineering Co., New York.
Whitlock Coil Pipe Co., Hartford, Conn.
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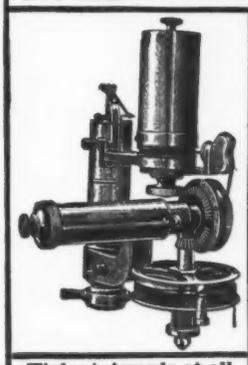

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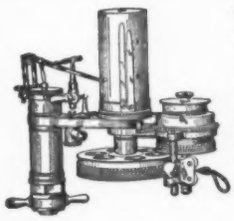

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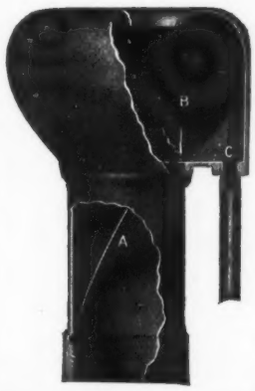

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Pittsburg Gage & Supply Co., Pittsburg, Pa.

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Sargent Steam Meter Co., Chicago, Ill.

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Governors, Pump

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Chaplin-Fulton Mfg. Co., Indianapolis, Ind.
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d'Este Co., Julian, Boston, Mass.
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Keystone Lubricating Co., Philadelphia, Pa.

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Webster & Co., Warren, Camden, N. J.

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Yale & Towne Mfg. Co., New York.

Hoists, Hand

Yale & Towne Mfg. Co., New York.

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Garlock Packing Co., Palmyra, N. Y.
Mercer Rubber Co., Hamilton Square, N. J.
N. Y. Belting & Packing Co., New York.
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Indicators, Gas Engine

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Hydraulic

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Speed

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Starrett Co., L. S., Athol, Mass.

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Crosby Steam Gage & Valve Co., Boston, Mass.
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Robertson & Sons, James L., New York.
Trill Indicator Co., Corry, Pa.

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Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.
Randle Mach. Co., Cincinnati, O.
Schutte & Koerting Co., Philadelphia, Pa

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Johns-Manville Co., H. W., New York.

Jacks, Hydraulic

Watson-Stillman Co., New York.

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Central Station Steam Co., Detroit, Mich.

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General Electric Co., Schenectady, N. Y.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

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Yale & Towne Mfg. Co., New York.

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Dearborn Drug & Chemical Wks., Chicago, Ill.
Dixon Crucible Co., Jos., Jersey City, N. J.
Keystone Lubricating Co., Philadelphia, Pa.

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Detroit Lubricator Co., Detroit, Mich.
Greene, Tweed & Co., New York.
Lunkenheimer Co., Cincinnati, O.
Ohio Lubricator Co., Wadsworth, O.
Philadelphia Lubricator & Mfg. Co., Philadelphia, Pa.

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Jeffrey Mfg. Co., Columbus, O.

Machinery, Crank Pin Turning

Underwood & Co., H. B., Philadelphia, Pa.

Machinery, Hoisting and Conveying

Allis-Chalmers Co., Milwaukee, Wis.

Machinery, Ice and Refrigerating

De La Vergne Machine Co., New York.
Triumph Ice Machine Co., Cincinnati, Ohio.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

Machinery, Second Hand

Randle Mach. Co., Cincinnati, O.

Machines, Blue Printing

Buckeye Engine Co., Salem, Ohio.

Machines, Portable Milling

Underwood & Co., H. B., Philadelphia, Pa.

Machines, Valve Reseating

Leavitt Mach. Co., Orange, Mass.

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Mercer Rubber Co., Hamilton Square, N. J.

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Green Fuel Economizer Co., Matteawan, N. Y.

Mechanical Stokers

Westinghouse Machine Co., Pittsburg, Pa.
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Allan & Son, A., New York.
St. John, G. C., New York.

Meters, Steam

Sargent Steam Meter Co., Chicago, Ill.

Meters, Water

Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.

Metal Polish

Hoffman, Geo. W., Indianapolis, Ind.

Oil Burners

Hammel Oil Burner Co., Los Angeles, Cal.

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Cook's Sons, Adam, New York.
Greene, Tweed & Co., New York.
Keystone Lubricating Co., Philadelphia, Pa.
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Oilers

Lunkenheimer Co., Cincinnati, O.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

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Burt Mfg. Co., Akron, O.
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Cook's Sons, Adam, New York.
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Packing, Asbestos

Diamond Rubber Co., Akron, Ohio.
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American Goetze Gasket & Packing Co., New York.
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Eureka Packing Co., New York.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
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Quaker City Rubber Co., Phila., Pa.
Restein Co., Clement, Phila., Pa.
Robertson & Sons, Jas. L., New York.
Steel Mill Packing Co., Detroit, Mich.
Vanda Co., New York.

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Johns-Manville Co., H. W., New York.
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Carey Co., The Philip, Cincinnati, O.
Diamond Rubber Co., Akron, Ohio.
Eureka Packing Co., New York.
Garlock Packing Co., Palmyra, N. Y.
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New York Belting and Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
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Mercer Rubber Co., Hamilton Square, N. J.
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Trimont Mfg. Co., Roxbury, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

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Saginaw Mfg. Co., Saginaw, Mich.

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Hill Publishing Co., New York.
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Saginaw Mfg. Co., Saginaw, Mich.

Pulleys, Clutch

Williams Fdry. & Mach. Co., Akron, Ohio.

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American Steam Pump Co., Battle Creek, Mich.
Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.
Wheeler Condenser & Engineering Co., New York.

Pumps, Boiler Feed

American Steam Pump Co., Battle Creek, Mich.
Kewanee Boiler Co., Kewanee, Ill.

Pumps, Centrifugal

Wheeler Condenser & Engineering Co., New York.

Pumps, Compound

Deane Steam Pump Co., Holyoke, Mass.

Pumps, Deep Well

American Steam Pump Co., Battle Creek, Mich.
Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.

Pumps, Electric

American Steam Pump Co., Battle Creek, Mich.
Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.
Wheeler Condenser & Engineering Co., New York.

Pumps, Force-Feed Oil

Greene, Tweed & Co., New York.
Lunkenheimer Co., Cincinnati, O.
Manzel Bros. Co., Buffalo, N. Y.

Pumps, Hydraulic

American Steam Pump Co., Battle Creek, Mich.
Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.
Watson-Stillman Co., New York.
Wheeler Condenser & Engineering Co., New York.

Pumps, Mining

American Steam Pump Co., Battle Creek, Mich.
Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.

Pumps, Oil

American Steam Pump Co., Battle Creek, Mich.
Deane Steam Pump Co., Holyoke, Mass.

Pumps, Oil—*Continued.*

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Detroit Lubricator Co., Detroit, Mich.
Du Bois Iron Wks., Du Bois, Pa.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Detroit, Mich.
Pittsburg Gage & Supply Co., Pittsburg, Pa.
Warren Steam Pump Co., Warren, Mass.

Pumps, Steam

American Steam Pump Co., Battle Creek, Mich.
Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.
De Laval Steam Turbine Co., Trenton, N. J.
Du Bois Iron Works, Du Bois, Pa.
Gardner Gov. & Sep. Co., Quincy, Ill.
McGowan Co., John H., Cincinnati, O.
Murray Iron Works Co., Burlington, Iowa.
Myers & Bro., F. E., Ashland, O.
Stewart Heater Co., Buffalo, N. Y.
Warren Steam Pump Co., Warren, Mass.
Wheeler Cond. & Eng. Co., New York.
Worthington, Henry R., New York.

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Deming Co., The, Salem, O.

Pumps, Turbine

Alberger Condenser Co., New York.
Wheeler Condenser & Engineering Co., New York.

Pumps, Vacuum

American Steam Pump Co., Battle Creek, Mich.
Wheeler Condenser & Engineering Co., New York.

Punches, Hydraulic

Watson-Stillman Co., New York.

Purifiers, Live Steam

Hoppes Mfg. Co., Springfield, O.

Purifiers, Water

Buckeye Boiler Skimmer Co., Toledo, Ohio.
Eclipse Feed Water Heater and Purifier Co., Appleton, Wis.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Keystone Chemical Co., Phila., Pa.
Northern Water Softener Co., Madison, Wis.
Wheeler Condenser & Engineering Co., New York.
Whitlock Coil Pipe Co., Hartford, Conn,

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American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Bristol Co., The, Waterbury, Conn.

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Schutte & Koerting Co., Philadelphia, Pa.

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Bristol Co., The, Waterbury, Conn.
Crosby Steam Gage and Valve Co., Boston, Mass.

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Crosby Steam Gage & Valve Co., Boston, Mass.
Lippincott Steam Specialty and Supply Co., Newark, N. J.
Robertson & Sons, Jas. L., New York.
Trill Indicator Co., Corry, Pa.

Refrigeration Machinery

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Triumph Ice Mach. Co., Cincinnati, O.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

Regulators, Damper

Berry Engineering Co., Chester, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Kitts Mfg. Co., Oswego, N. Y.
Lagonda Mfg. Co., Springfield, O.
Robertson & Sons, Jas. L., New York.
Watson & McDaniel Co., Phila., Pa.

Regulators, Feed Water

Berry Engineering Co., Chester, Pa
Chaplin-Fulton Mfg. Co., Pittsburg, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Phila., Pa.

Regulators, Pressure

Davis Co., John, Chicago, Ill.
Davis Regulator Co., G. M., Chicago, Ill.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Marshalltown, Iowa.
Foster Engineering Co., Newark, N. J.
Mason Regulator Co., Boston, Mass.
Ohio Brass Co., Mansfield, O.
Robertson & Sons, Jas. L., New York.
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Leavitt Mach. Co., Orange, Mass.

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Garlock Packing Co., Palmyra, N. Y.
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Engberg's Electric & Mechanical Works, St. Joseph, Mich.

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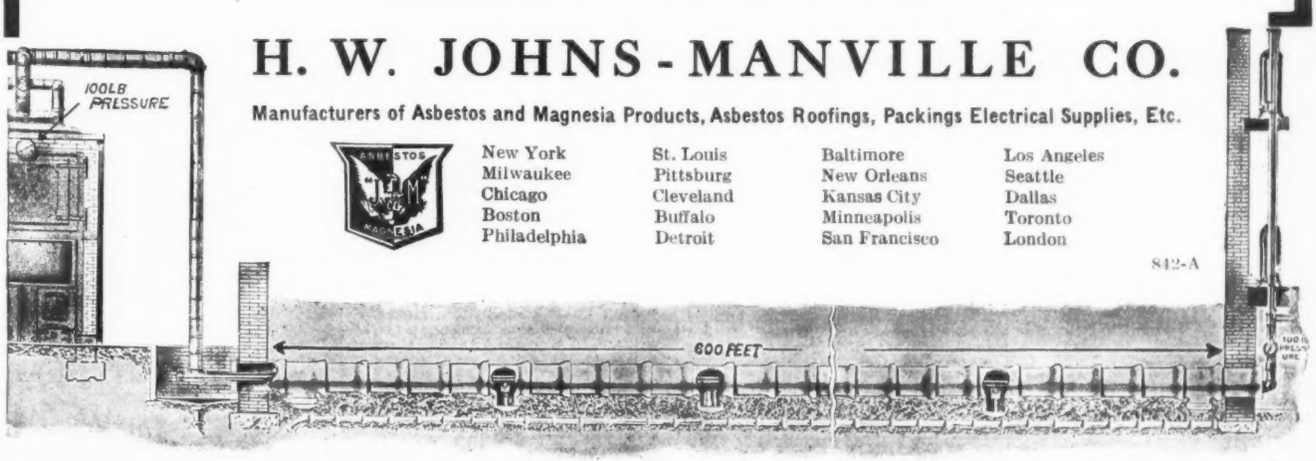

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Watson & McDaniel Co., Philadelphia, Pa.

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Valves, Automatic Relief

Walch & Wyeth, Chicago, Ill.

Valves, Back Pressure

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Pittsburg Valve Foundry and Construction Co., Barberton, O.
Walch & Wyeth, Chicago, Ill.

Valves, Blow-off

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Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

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Crosby Steam Gage & Valve Co., Boston, Mass.
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Williams Valve Co., D. T., Cincinnati, Ohio.

Valves, Electro-Hydraulic

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Valves, Exhaust Relief

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Schutte & Koerting Co., Philadelphia, Pa.

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Pittsburg Valve and Fittings Co., Barberton, O.
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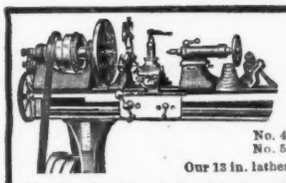

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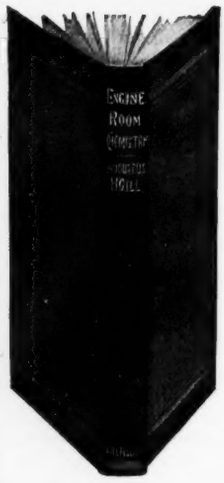

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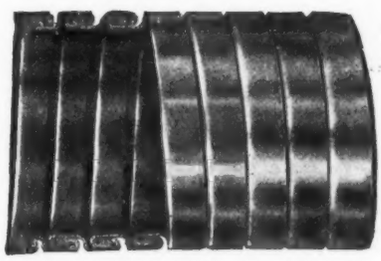

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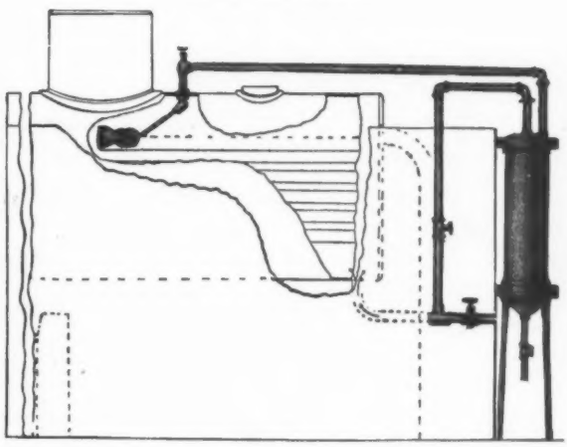

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1

New Gas-Electric Power Plant at Gary, Ind.

By Claude Aikens

Here is the first available advance information of the new works of the U. S. Steel Corporation, at Gary, where seventeen huge gas-engine-electric generating units are being installed. When completed, this will be the largest power station in the world. *Power and The Engineer keeps you posted on all the new things.*

2

Allowing for the Expansion of Steam Pipes

By Prof. William D. Ennis

There have been a great many articles treating of the Expansion of Pipes, but this one is different. It goes to the root of the matter—comprehensively and almost exhaustively—and among other things, shows plainly, in everyday language, how to allow for the effects of temperature rise, what results the different strains produce, what is the best way to allow for expansion and how much expansion to allow for. *Power and The Engineer is always on the expand—growing better with every issue.*

3

The High Pressure Hydraulic Elevator

By William Baxter, Jr.

We are going to start anew the Hydraulic Elevator series, broken off in April, with the August 18th number. Following the High Pressure Elevators, Plunger Elevator Systems will be described. The series will be exceedingly interesting and of great educational value. *Power and The Engineer never neglects any subject of power-plant engineering.*

4

A Combined Power and Hot Water Heating Plant

By Charles L. Hubbard

An article designed to show the general management of the special apparatus required in a system of forced hot-water heating, when used in connection with a power plant. A description of such an installation is given, plentifully illustrated, and engineers who are interested in hot-water heating will like this. *Power and The Engineer covers the field.*

5

The Development of Non-Metallic Packings

By W. E. Sanders

The author is at the head of the packing department of a large rubber company. He knows all about non-metallic packings. He tells of the early forms, of troubles Watt had with packings, of how packings should be classified, of "monkey-wrench" packings and of moisture packings and the subject is presented in a new, interesting and educational manner. *"Fine!" says the editor, and he knows.*

6

Power System of the Henry Vogt Machine Co.

By Osborne Monnett

This is a detailed description of an up-to-date steam-electric power plant, in Kentucky, which furnishes an excellent example of concentration of power-generation equipment. The lay-out is exceptionally convenient and altogether it is an interesting plant. A desirable feature is the completeness of the system for keeping records of the performance of the apparatus. *Power and The Engineer enables you to benefit by the experiences of others.*

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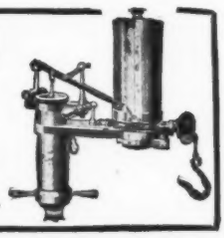

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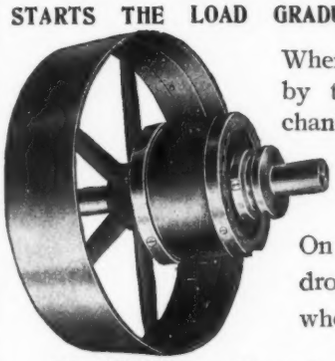

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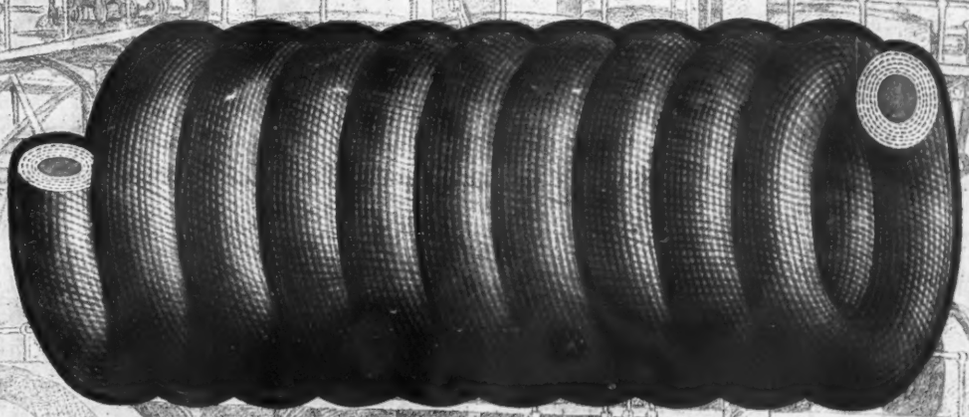

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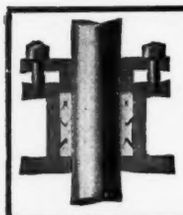

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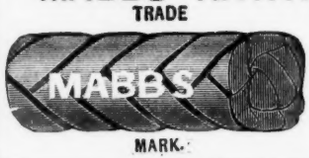

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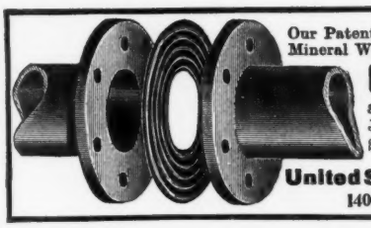

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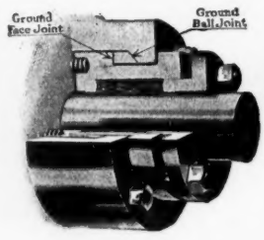

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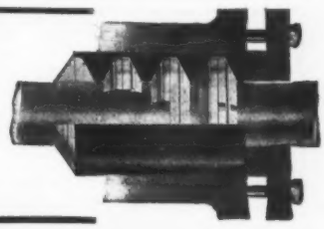

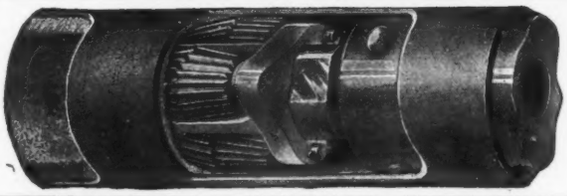

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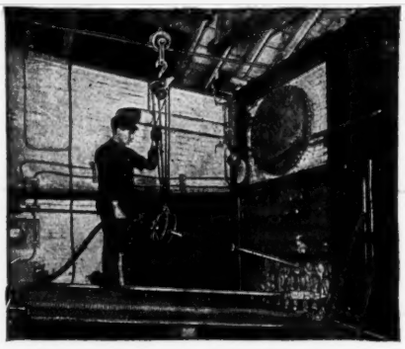

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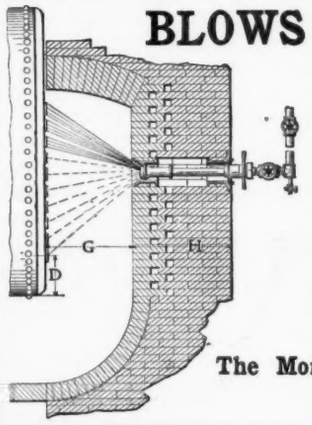

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But even here, she sees quite clear
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The same glad sight, that makes things right
No matter what the test
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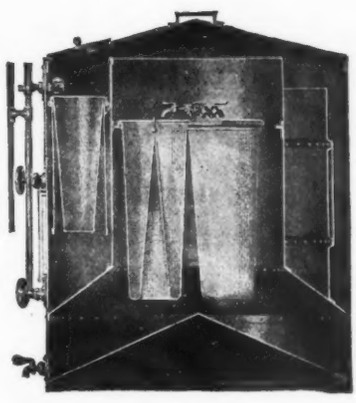

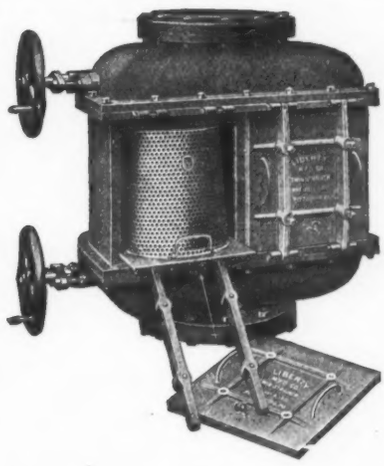

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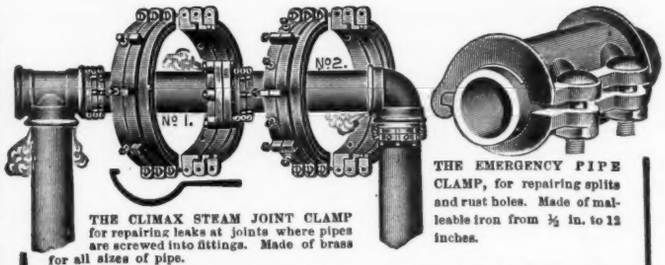
FOOL PROOF REDUCING VALVE

is set with a removable key which the engineer carries. It can't be tampered with. *CATALOG?*

THE MASON REGULATOR CO.,
BOSTON, MASS.

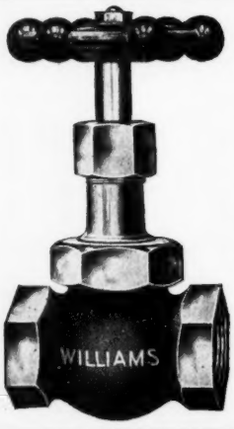


THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.

THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ½ in. to 12 inches.

PIPE REPAIRS FOR ANY CONDITION

Send for Catalog of
STEAM SPECIALTIES
JAMES McCREA & CO.,
MANUFACTURERS,
61 West Washington Street, Chicago.



For Economy's Sake--Use Williams Valves

Modern engineering practice has clearly demonstrated that the *regrinding valve* is the most economical, because it successfully controls steam or liquids at high pressures and temperatures without the difficulties experienced with other types of valves.

As the Williams valve is of the regrinding type, it does not require the use of extra discs or seats should it ever become worn. That's why it's economical and that's where it will save you money. *Regrinding* the disc or seat is a *simple operation*, quickly accomplished without the use of special tools or even breaking a pipe connection. When completed the valve is as good as when new, at *no extra cost*. Guaranteed for 200 pounds pressure, the Williams is seen at its best where all other valves fail.

Let your next order read—WILLIAMS.

THE D. T. WILLIAMS VALVE COMPANY,
904-910 BROADWAY, - - - CINCINNATI, OHIO.

You Cannot be Interested in Power Plant Equipment

Unless you are Interested in

"P" VALVES and FITTINGS

Because We Claim Them To Be The Finest Product of Their Kind.

ALWAYS SPECIFY P VALVES and FITTINGS

ALWAYS SPECIFY P VALVES and FITTINGS

PITTSBURGH VALVE AND FITTINGS COMPANY,
General Offices and Works, BARBERTON, OHIO.

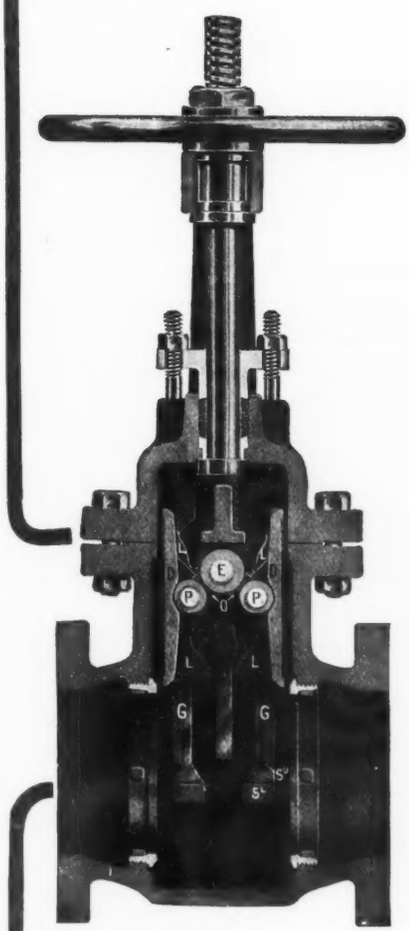
WE MANUFACTURE ALL KINDS OF VALVES AND FITTINGS. WRITE FOR CATALOGUE

SCHUTTE

SUPERHEATED STEAM

GATE VALVES

The "Schutte" Gate Valves have two disks, the construction of which is so that they are first drawn from the seat before they can begin vertical movement, therefore—no scraping on seat—no tendency to deform shape of body—are easy to operate—friction reduced to a minimum.

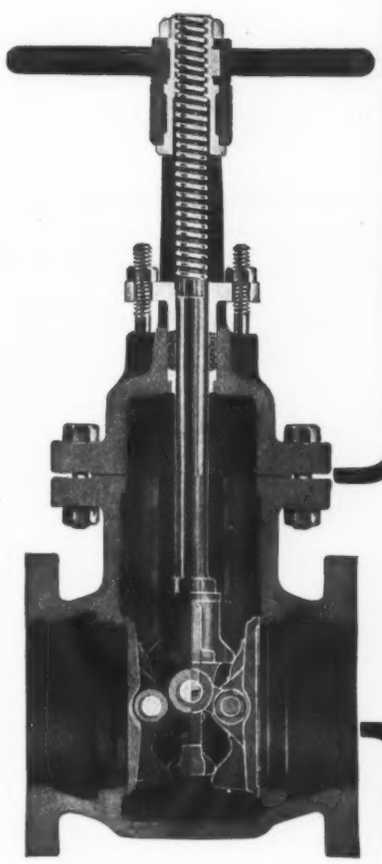


These valves have been installed in a number of the largest modern high pressure superheated steam plants of the country, and have proven highly satisfactory.

Openhearth Steel or Air Furnace Iron is used for the body and bonnet, according to the degree superheat. The working parts are made of "Mo-nickel," according to requirements—which metal has a tensile strength of 65,000 to 80,000 lbs. per square inch, and is non-corrosive.

We make all kinds of Valves for all purposes—saturated and superheated steam.

Write for Catalog 8-G.



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Boston: 43 High St.

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PHILADELPHIA

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Pittsburg: Keenan Bldg.
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DAVIS PRESSURE REGULATORS SAVE STEAM

PRESSURE REGULATOR

Do It Automatically

If you are using live steam for heating, drying, cooking or some other purpose at a pressure lower than that carried on the boiler, let the Davis Pressure Regulator make the reduction for you automatically.

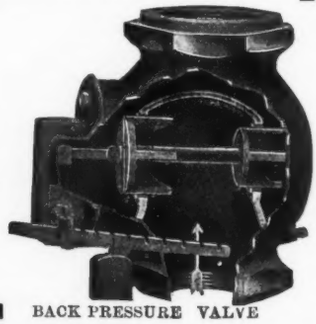
This valve can be adjusted to deliver steam at just the pressure needed and it will maintain that pressure without fluctuations no matter how much the initial boiler pressure may vary.

Reducing steam by throttling through a cracked globe or gate valve is about as satisfactory as using saw dust for fuel. You may be able to get along after a fashion, but why not do it right—automatically.

If you are running your engine non-condensing a Davis Automatic Back Pressure Valve will enable you to make use of the exhaust steam instead of letting it go to waste.

Contrast this valve with its semi balanced disc, small weight and noiseless operation without any possibility of injury to the seats, with the old style single seated valve which pounds like a trip hammer and keeps you poor buying seats for it. Is there any comparison—would you choose the single seat ?

Send for a complete catalog of Davis Valve Specialties. It is of interest to both owner and operator.



BACK PRESSURE VALVE

G. M. Davis Regulator Company,

142 Milwaukee Ave., CHICAGO.

BRANCHES—NEW YORK—123 Liberty St. BOSTON—104 High St. ST. LOUIS, 735 S. 4th S.
SAN FRANCISCO—216 California St PHILADELPHIA—56 N. 2nd St.
PITTSBURGH—1206 Park Building.

VALVES

Makes no difference what kind of a Valve you want, how you want it made or where you want it shipped, we can supply it on shortest possible notice.

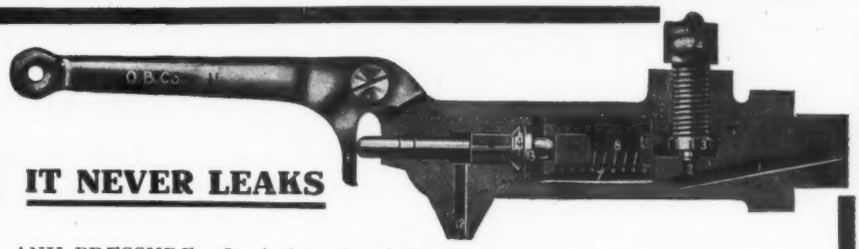
We manufacture valves and pipage equipment of every description, for all kinds of plants, Steam Separators, Tuyere Cocks, Brass Unions, Etc. Also make Pipe Bends, and do all kinds of Pipe Fitting, either assembled or ERECTED.

SEND FOR CATALOG

PITTSBURGH VALVE FOUNDRY & CONSTRUCTION CO.

Pittsburgh Cleveland New York Boston Birmingham, Ala.

COLLIN GAUGE COCK

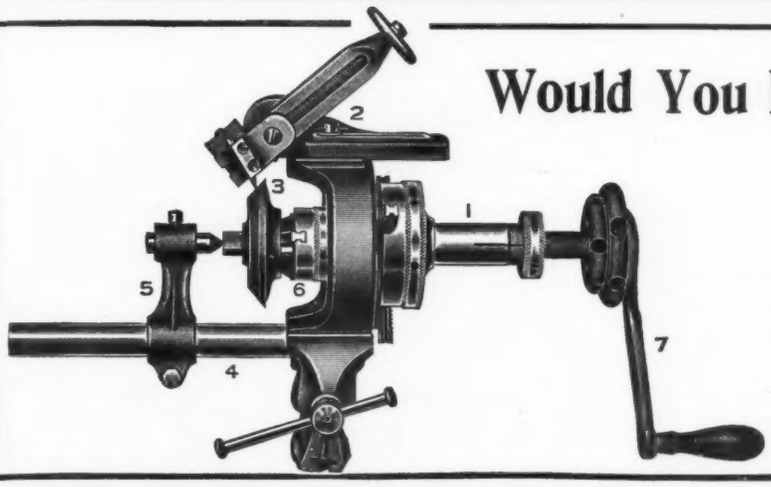


IT NEVER LEAKS

IS ABSOLUTELY TIGHT UNDER ANY PRESSURE. In closing, the piston "13" enters the cylinder, cutting down the velocity of the fluid through the seat "14" and preventing steam-cutting as the valve closes. A slight movement of the lever reduces velocity of discharge and prevents flashing. Made of high grade steam bronze and with or without packless, non-sticking shut-off valve.

WRITE TO-DAY FOR CATALOGUE No. P-F, describing all our steam specialties, including Water Gauges, Gate Valves and Heavy Bronze Fittings and CATALOGUE P-B describing Collin Steam Pressure Regulating Valves.

THE OHIO BRASS CO., MANSFIELD, OHIO. CHICAGO OFFICE 277 DEARBORN ST.



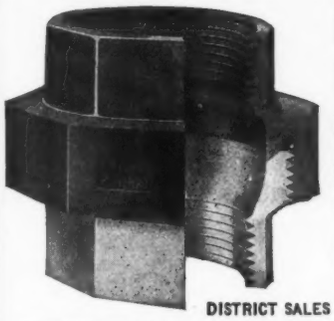
Would You Hesitate One Minute

ordering a Dexter Valve Reseating Machine if you were positive it would keep your valves perfectly tight, and the machine would save enough to pay at least half its cost before the bill became due?

You can have a machine 30 days, use it all you care to and then return it at our expense if you do not want it.

Send for Catalog P. illustrating these machines.

THE LEAVITT MACHINE CO.,
ORANGE, MASS., U. S. A.



Never Rust Never Leak

The "Kewanee" Union stays permanently tight. No gasket is used for the brass to iron ball joint seat makes a tight seal. Easy to disconnect and reconnect. Don't you want more information?

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Pittsburg, Pa.

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A great many problems may have arisen before you, that might have seemed improbable, but which have been made possible by the Foster Valve Specialties.

We guarantee, should you tell us, under what trouble you are laboring, to alleviate these troubles with one or another of our specialties, as the occasion demands.

You need not feel that you are committing yourself when you send us an inquiry, but we feel that when we learn all we can stand up for in regard to our specialties, that you will deferentiate in their favor.

Send in your inquiry. We have catalogs that tell all about all our specialties.

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NEWARK, N. J.

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Stock carried at
Adkins, Young & Allen Co., 50-52 S. Canal St., Chicago, Ill.

EMERGENCY WORK IN POWER PLANTS MUST BE DONE IN A HURRY.

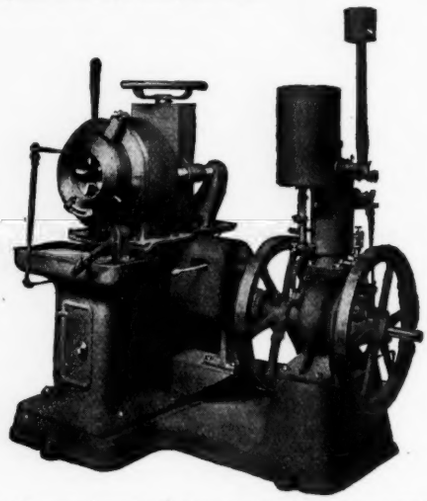
"TOLEDO" Pipe Threading Devices

thread pipe up to 12". ONE MAN can do it quickly and *in any place, in any position.* An invaluable line of tools. Let us tell you about them.

The Toledo Pipe Threading Machine Co.,
TOLEDO, OHIO.

The Loew Victor Gas Engine Driven Outfit

Self-contained—can be operated at any place, regardless of location or conditions, as no outside power is required—always ready for work.



In the manufacture of pipe machines, we have made a careful study of all classes of pipe threading, designing a complete line of machines, each one being the most perfect adaptation for the given work it is to perform.

Send for Catalog of Belt, Motor and Gas Engine Driven Types.

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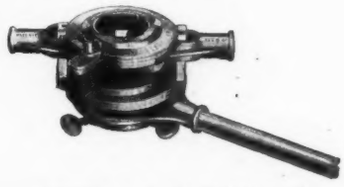
"BEAVERS" are the proper die stocks for use about factories

BECAUSE they are built on the easy working principle, enabling one man to thread any size pipe without calling for help.

Each Stock threads all sizes of pipe within its range without changing dies so you have no loose parts to carry around or get lost or misplaced.

And consider the time you save by not having to change dies.

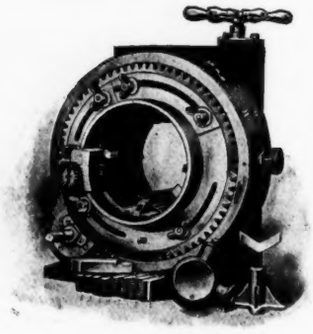
They are a time proven success and of such practical advantage in saving time and labor as to compel their use from an economical standpoint once you realize it.



"Beaver" 1" to 2" Ratchet Stock.

Made in all sizes ¼" up.
Sold by all Jobbers subject to 10 days' trial.
We would like to send you descriptive matter.

THE BORDEN COMPANY
WARREN, O.



Put This In Your Pipe

Cutting and Threading Department if you want a reduction in expenses.

FORBES PATENT DIE STOCK

is compact, strong, simple and portable. It is the only machine on which shell can be adjusted to take up the wear of the gear and this feature insures a perfectly straight thread and prolongs the life of the machine. With the "Forbes" one man can easily cut off and thread all sizes of pipe up to 15" by hand.

Learn all the economy-promoting details.

Catalog ?

THE CURTIS & CURTIS CO.,
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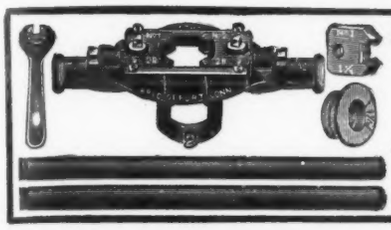
MANGANESITE PASTE
(TRADE MARK REGISTERED)
A Superior NON-POISONOUS Jointing Material of Metallic Composition; for FLANGE and SCREW-JOINTS of every description on Steam, Water, Air, Gas, Ammonia, etc. UNITES TWO METALS AS ONE. Cheaper, more efficient than red lead—no waste in its use.
WALCH & WYETH, 87 Lake St., CHICAGO.
Manufacturers of the Erwood Straightway Swing Gate Valve. Many valuable features in one valve. Write for Catalog.


STOCKS AND DIES,
PIPE MACHINES,
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Manufactured by
The Armstrong Mfg. Co.
287 Knowlton St.,
BRIDGEPORT, CONN.

JEFFREY
Pivoted Bucket
CONVEYOR
HANDLING
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GRAB BUCKETS,
STORAGE BINS, CRUSHERS,
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In Proportion To Your Knowledge

Education is not so much a matter of remembering facts as knowing where to get them when you want them. This Pressure Recording Gage puts the facts of your plant in easy reach and keeps them there.
WRITE FOR OUR CATALOG.
THE ASHTON VALVE CO.
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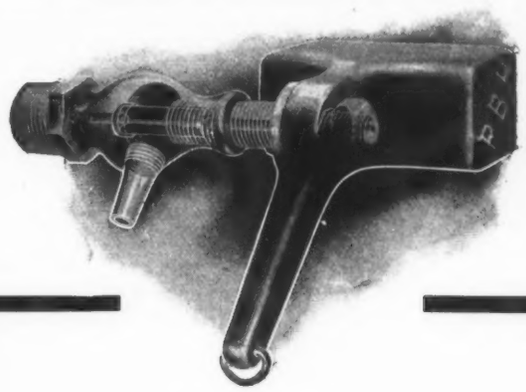
A Few Cents
Replace the Valve Pencil
and that's the only part about the "P.B.H." Weight Gauge Cock that needs renewing.
The "P.B.H." is quick opening, self-closing and guaranteed *leakless* for years and years. Keeps the boiler free from dirt and drizzle. Yours on a 30 days' trial to *prove its value.* *WRITE!*
The Paul B. Huyette Company, Inc.
2025 Betz Building, Philadelphia

DEBUT
It is needless to say that steel pipe requires a sharp, properly shaped die to produce good threads. The little machine shown here is the
B. & K. DIE GRINDER
for the correct grinding of the dies. Simple to operate, modern in price, and will save you dollars. Shall we send description ?
BIGNALL & KEELER MFG. CO.
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SHULTZ SABLE IS BEST

We use only A-1 heavy packer steer hides, which tanned by our especial process, make belts with soft kid-like surface, and strong, tough pliable interior.

This soft surface permits SHULTZ SABLE BELTS to hug the pulley closely without slip or waste in power, even when run slack.

SABLE remains flexible without being "doped," gives from ¼ to ⅓ more pulling power than any oak-tanned belting and is especially fitted for quarter turn or cross drives or small pulleys.

Try a SABLE BELT 60 days' free.

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MANUFACTURERS OF
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Sales Agencies in all principal cities.
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Robins Laminated Leather Belting

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SOLVES THE BELT PROBLEM.

The Scientific Principle:
Continuous strands are spirally cut from the choicest leather locations of the belting butt to exact mechanical gauge. The strands are then separately stretched to the extreme elastic limit and assembled on edge forming a belt of any practical length, width or thickness. Made endless on pulleys with a simple interlocking splice.

The Positive Result:
A continuous belt without laps, plies or cement. Absolute uniformity of strength, gauge, balance and flexibility. Complete adjustment to varying pulley conditions with the maximum of surface and circumferential contact. Remarkable power transmission and highest productive efficiency.

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BELT HEALTH

is as much dependant on cleanliness as is yours and mine. Belts that have been **doped** for years with gummy, sticky nostrums are **sick,** and **can't** do a good day's work no matter how hard you try to make them. There's no life in them, no **grip,** they are **thick** and **heavy,** and the only remedy is

OXoilOX

nature's belt food, made from the hoofs of cattle. It drives out this old gummy stuff; leaves the belts soft, tough, and clean. Then they **have** life and health. They cling so closely to pulleys that all air is excluded and the vacuum thus formed enables a belt to run slack at its full capacity without slipping. Start **new** and **right** with **OXoilOX.**

FREE

F. S. WALTON CO., Philadelphia, Pa. Gentlemen: Kindly send us, free of all charge, a sample can of OXoilOX, the perfect belt dressing.

NAME _____ NAME OF FIRM _____
ADDRESS _____
NUMBER OF BELTS _____ AVERAGE SIZE _____

F. S. WALTON CO. Pressers and Refiners of all grades of Neatsfoot Oil. **PHILADELPHIA, PA.**

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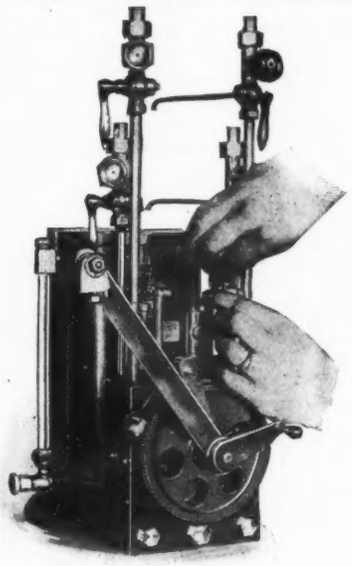

If you use a LATEST IMPROVED

ROCHESTER

AUTOMATIC LUBRICATOR, it's the simplest thing in the world to adjust any one or more of the feeds so that they will feed anywhere from a fraction of a drop per minute to an almost continuous stream. Isn't this to be considered when purchasing a Lubricator for your engine or pump?

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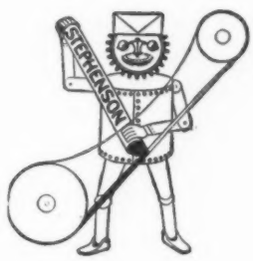
SAMPLES SPEAK LOUDER THAN WORDS



And there is no **string** to this method of selling our

STEPHENSON
Bar Belt Dressing

Send us 2c. for testing Sample, and say which:

Red Label for **Leather** belts.
Green Label for Rubber or Canvas.
No **one** kind is good for **all** belts—
you know that.

Of Dealers Everywhere, or

STEPHENSON MFG. CO.
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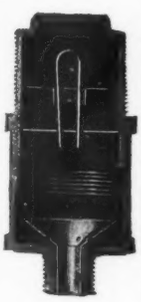
Agents for England:
J. B. Stone & Co., Finsbury Pavement, London.

The "Philadelphia" Grease Cup



Automatic application of grease to the bearing without the use of spring compression. : : : :

Nature Supplies the Feeding Force in the Form of Compressed Air. : : : : : : :

With many thousands of the "Philadelphia" Grease Cups in successful operation, on machinery of almost every description, we offer a system of lubrication which, for simplicity, cleanliness, economy, reliability and efficiency has no equal.

The "Philadelphia" Cup is not merely "as good as any other:" IT IS THE BEST, and we are prepared to prove our claim for actual superiority. There are more reasons for its practical success than we have room to mention here.

Write for catalogue and full information

The Philadelphia Lubricator & Manufacturing Co.
The Bourse (Exhibition Dept.), Philadelphia, Pa.

SAY!

Why Haven't You Written For A Detroit Lubricator ?

We've told you frankly that more Detroit Lubricators are sold than all our competitors combined—over 950,000 in daily use.

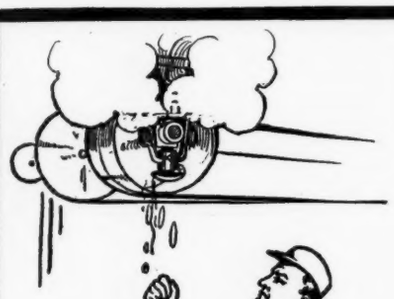
We've told you how its operation depends upon the action of natural laws and how it will save oil and work positively.

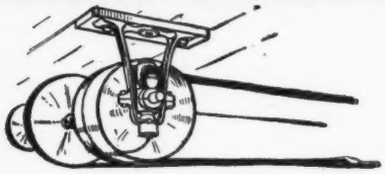
20 Days' Free Trial.

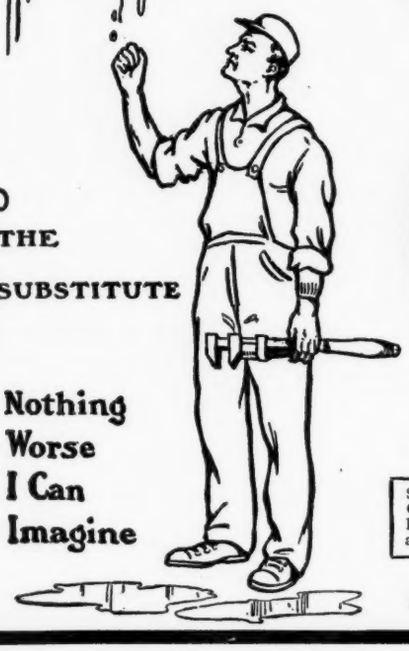
Detroit Lubricator Co.
DETROIT, U. S. A.

THERE IS ONLY ONE

ALBANY GREASE







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Send for FREE sample cup and can of "Albany Grease," giving size of tap for cup, depth of oil hole from top of cap to journal, where to be used and firm's name.

MADE ONLY BY
ADAM COOK'S SONS,
313 WEST ST., NEW YORK.

NOTHING EASIER

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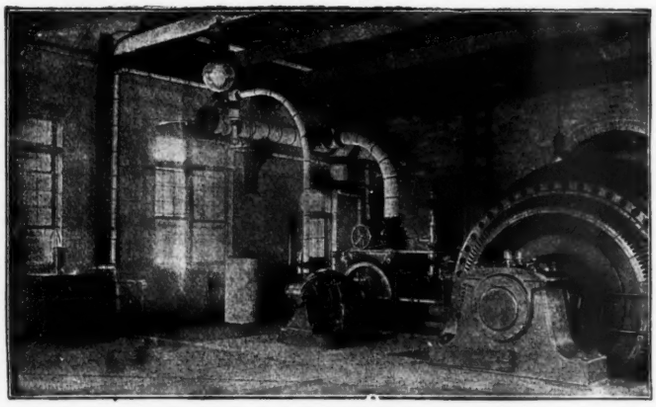
THE ONLY GENUINE

Engine Oiling In The Modern Power Plant



Down in what most people regard as the wildest part of south central West Virginia, in the territory from which some of our finest smokeless fuels are secured, is the McKell Coal & Coke Co., Glen Jean, W. Va., operating collieries scattered at convenient points over a tract of several thousand acres. Electric power for operating these numerous scattered mines is supplied by an alternating current system of distribution from a central power plant. High-tension alternating current is transmitted from the central station to scattered substations, where it is transformed and converted into low-tension continuous current for use at the adjacent mines.

The illustration shows the first 500-k.w. alternating current generating unit in the power house, which provides space for installation of a duplicate unit. At the left may be seen the Duplex Type White Star Oil Filter and circulating pump of the White Star Continuous Oiling System here in use for lubricating all the engine bearings. Overhead, out of sight among the roof trusses, is a reservoir from which the oil is piped to feeds fitted to all the bearings on the engine. All oily drips from the various bearings are drained to a tank beneath the engine room floor, from which they are lifted automatically to the White Star filter on the engine room floor. After being thoroughly cleaned in the filter, the oil is pumped back to the overhead reservoir, ready for use again. Thus there is a constant stream of oil fed to all bearings, amounting in this case to a circulation of about 200 gallons per day. The reservoir is so arranged that any excess pumped to it would be returned through automatic valves to the filter.

By use of the White Star continuous oiling system the bearings are all supplied with a copious flood of oil, affording that generous supply which is known to be necessary to perfect lubrication, yet *absolutely without waste*, since not a drop of oil can escape from the system, except as it is actually worn out in the bearings.

We are prepared to equip power plants of any size contracting to furnish the necessary apparatus or erecting such outfits complete. Our catalog "D" treats fully on this subject. Send for it.

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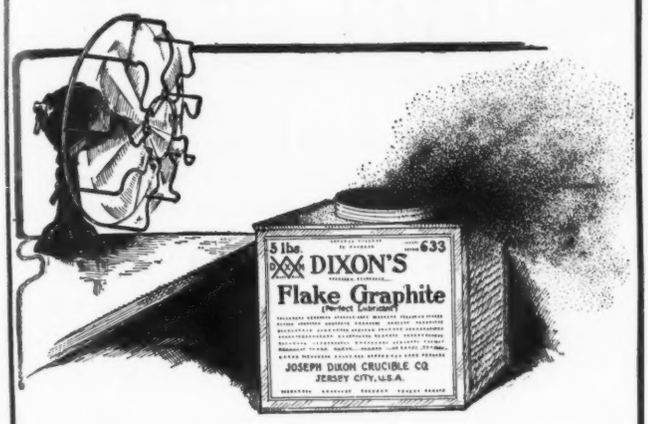

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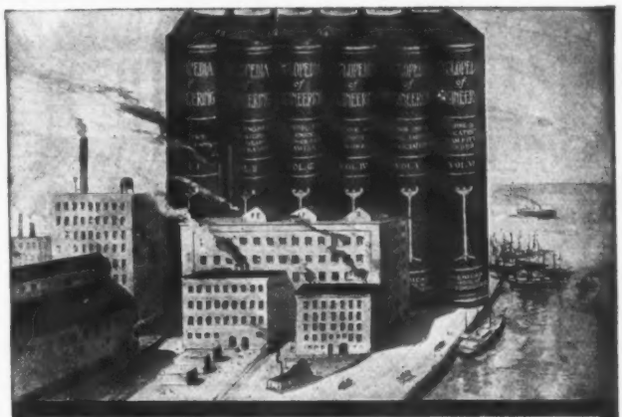

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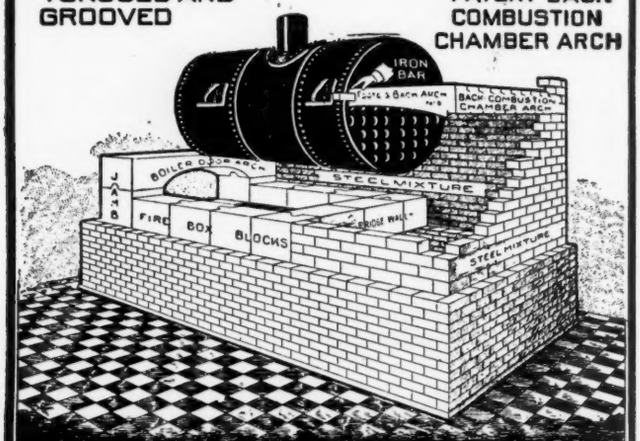

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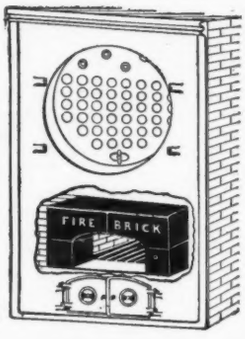

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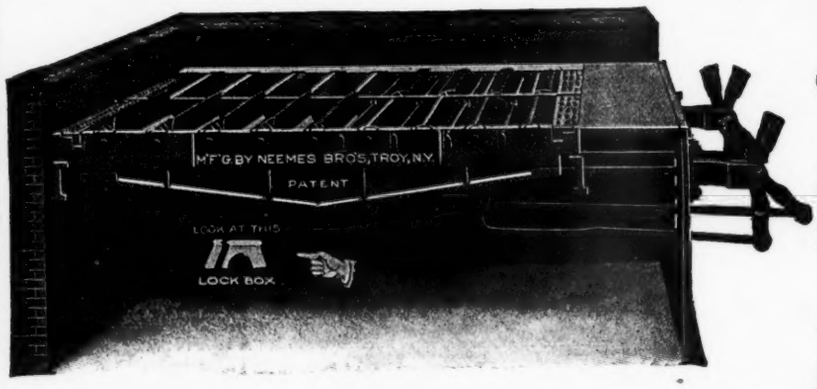

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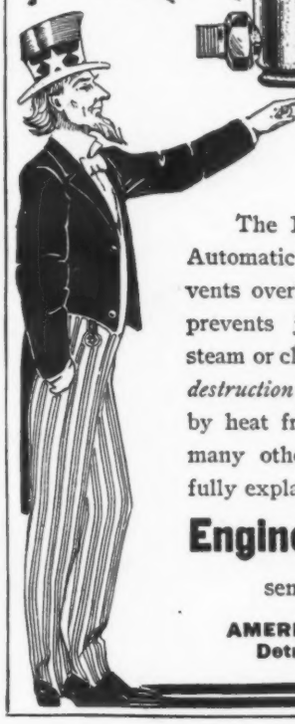

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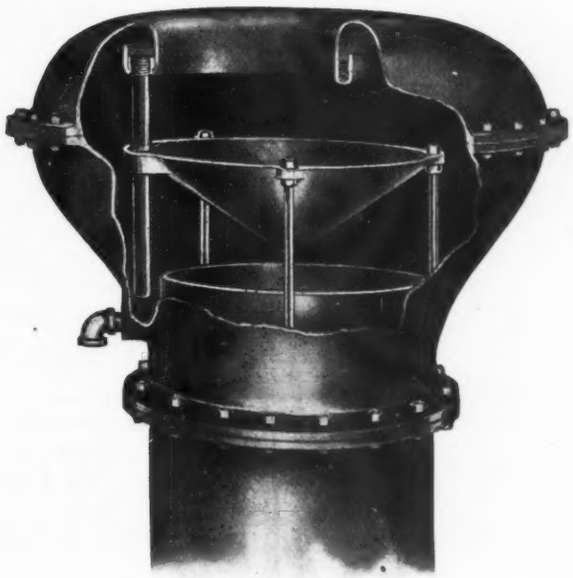
CAST  IRON

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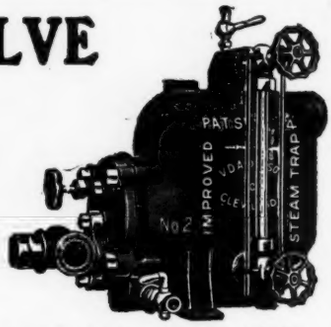

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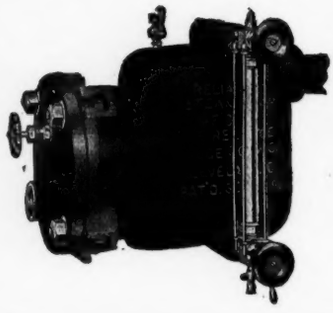
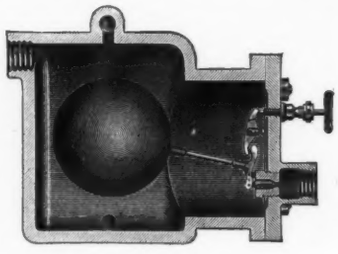


It will not require any more of your attention after the first adjustment and it can be depended upon to continually discharge all the condensation without loss of steam.



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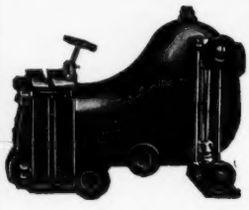

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are especially adapted for draining steam separators and high pressure mains. Also good for steam heating. All working parts are attached to the bonnet, and are removable with it. Valve outlets are large, to give rapid discharges of condensation.

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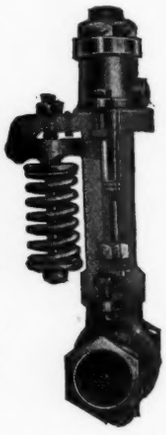

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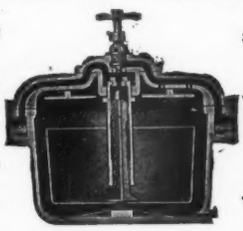

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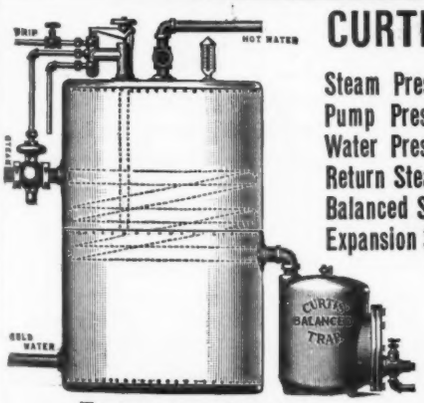

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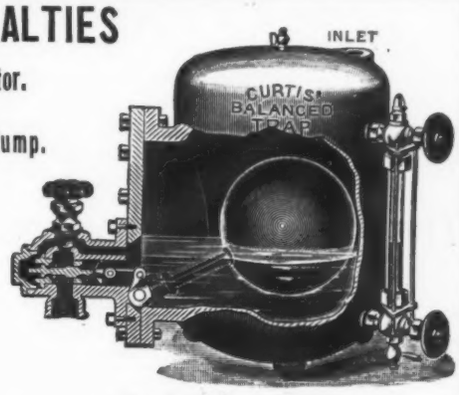

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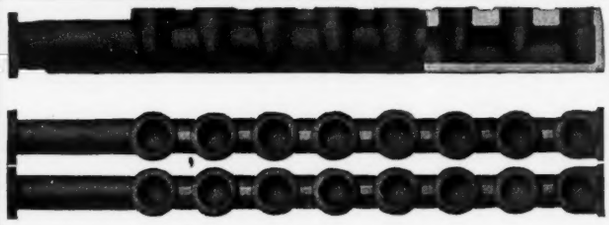

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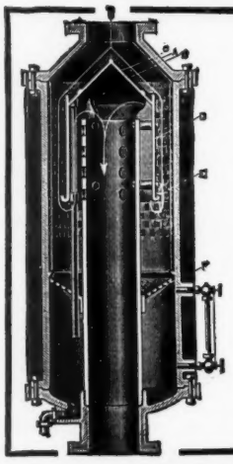

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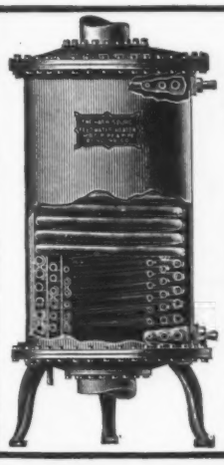

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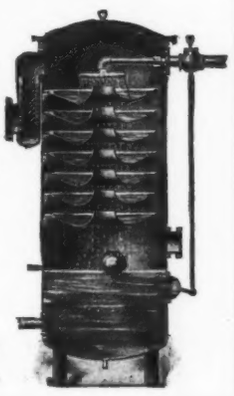
950 Herr Street, HARRISBURG, PA.

The Wickes Heater

Exhaust steam utilized for heating water for boiler feed or laundry work.

Simple, effective, durable. Tested like a boiler.



The Wickes Boiler Co.
MAIN OFFICE AND WORKS:
Saginaw, Michigan
SALES OFFICES:
1411 West St. B'ld'g, West and Cedar Sts., New York City.
1139 American Trust B'ld'g, Chicago, Ill.
Penobscot B'ld'g, Detroit, Mich. Empire B'ld'g, Pittsburg, Pa.
601 Brown-Marx B'ld'g, Birmingham, Ala.

Heats Thoroughly And Holds The Heat

No single shell heater could possibly extract so large a percentage of exhaust steam heat as the

Baragwanath Steam Jacket Feed Water Heater

for the simple reason that without the steam jacket a certain amount of heat is bound to escape into the air. Write for the catalog which gives full details.

WM. BARAGWANATH & SON,
54 West Division St.,
CHICAGO, ILLINOIS, U. S. A.

Thos. B. Whitted, Piedmont Bldg., Charlotte, N. C., Southeastern Manager.

60 Days' Trial

gives you plenty of time to test the

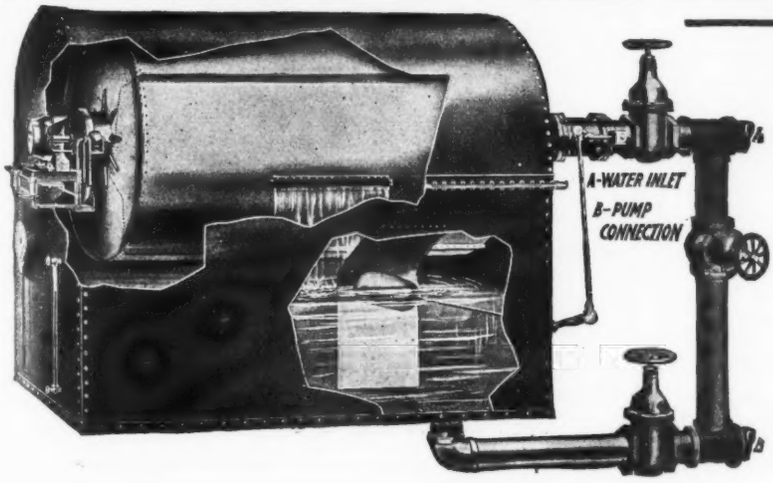
Patterson-Berryman Feed Water Heater

under all the varying conditions incident to service in your plant.

Unless you are entirely satisfied it will not cost you one cent even for transportation.

WRITE!

Frank L. Patterson & Co.
28 Cortlandt Street, New York, U.S.A.



What Are Your Boilers Doing?

Are you getting the best economy?
Is your coal best fitted for your purpose?
Can You Tell Your Evaporation?
A
DETROIT METER
Will Give You a Continuous Record of Your Boiler Feed Water

Built in all sizes for all requirements of power plants, heating companies and for measuring any liquid.

CENTRAL STATION STEAM COMPANY
Detroit, Mich., U. S. A.
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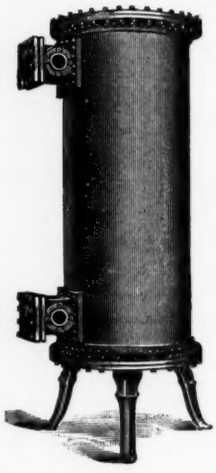
Heat the Feed Water and Save Boiler Repairs



National Feed Water Heaters

Nearly 3,000,000 H. P. In Use

No inside joints or straight tubes to leak, back pressure impossible, no contact of water with the shell, no chance for grease in the boiler. They save coal, protect the boiler from sudden contraction, cost little to purchase, install and maintain. Write.

THE NATIONAL PIPE BENDING CO.
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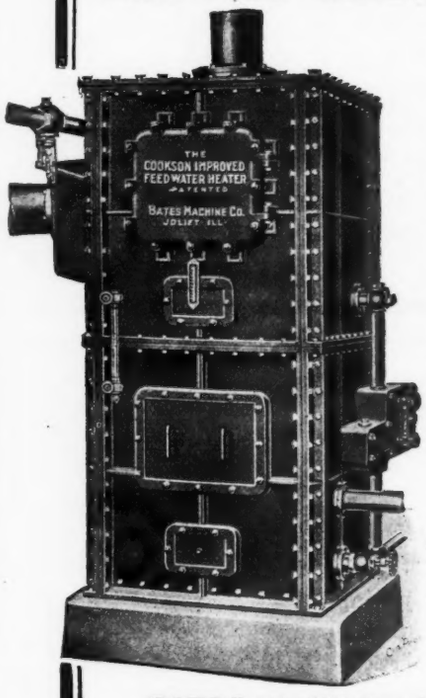
120 Liberty St., NEW YORK. 54 High St., BOSTON, MASS.

COOKSON STANDARD ALL CAST IRON FEED WATER HEATERS



Highest Temperature and Positive Purification of feed water.

Perfect Separation and Removal of Oil.

Automatic Control of Cold Water Supply.

Dry Steam for Heating Purposes.

Finest Grade Special Fittings.

Lime Catching Pans. Especially Adapted for use with Heating Systems, Dryers, Etc.

Write for our new Heater Catalog.

BATES MACHINE COMPANY
Sole Manufacturers Joliet, Illinois

The Otis Tubular Feed Water Heater

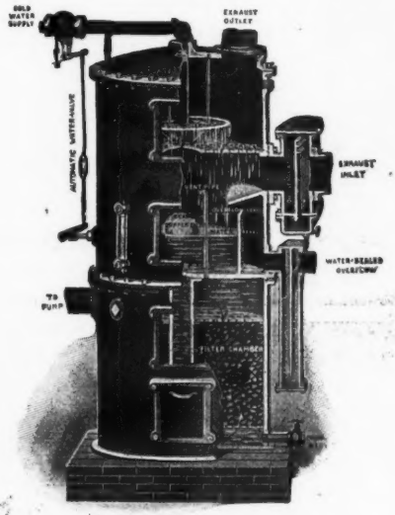
A square foot of heating surface to every horse power.

A simple construction which makes cleaning and repairs easy.

Ask for further advantages.

The Stewart Heater Co.,
45 E. Delavan Ave.,
Buffalo, New York.

THE WHITLOCK OPEN EXHAUST Feed Water Heater and Purifier



Perfect Oil Separation. Easily Cleaned. The Highest Possible Temperature in the Feed Water.

Manufactured by

THE WHITLOCK COIL PIPE COMPANY
HARTFORD, CONN.
New York Office—Singer Building, 85 Liberty Street.

THE JOHN H. McGOWAN CO.
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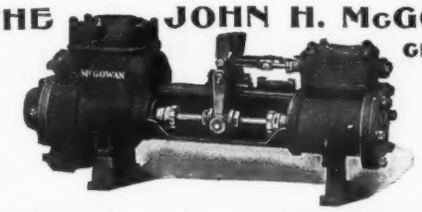
Builders of
PUMPING MACHINERY
Single Duplex and Fly-Wheel Types
Water Works Pumping Engines



MYERS POWER PUMPS
Adapted especially for gas engines, motor and belt powers, in harmony with present requirements.
Catalog sent on request.
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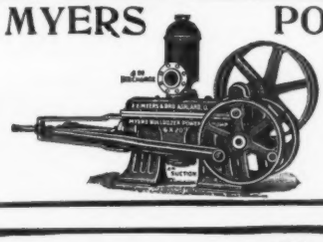
Ashland, Ohio, U. S. A.



GOULDS
EFFICIENT POWER PUMPS
Built in the best manner and of material that can be depended upon. They will be found to fully sustain the high reputation of
GOULDS QUALITY
THE GOULDS MFG. CO.,
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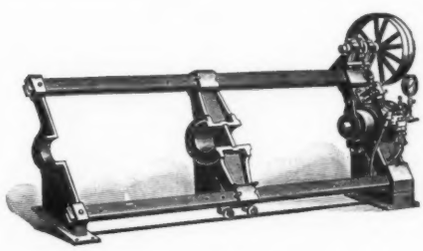
New York. Philadelphia. Pittsburg. St. Louis. New Orleans. Chicago. Los Angeles. San Francisco. Louisville.



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Our many years in the hydraulic line has enabled us to accumulate many drawings and patterns of all types of hydraulic presses. We have manufactured presses for almost every purpose.
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50 Church Street, New York City.
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F. L. RAY

THE possibilities of your securing a raise in salary depend 90% on one thing—upon your securing the knowledge and **training** that will really qualify you to hold a higher position commanding a larger salary. Such training has helped thousands of men in the same way that it helped Frederick L. Ray to advance from work as a machinery erector to power superintendent for the Stanley Rule & Level Company, of New Britain, Conn., and later to superintendent of construction for W. M. Sheehan & Co., New York City. Mr. Ray's earnings have, of course, increased very largely since he became an I. C. S. Trained man—for it was through the I. C. S. that he secured his training. It is **training** that counts. You **must** bring training into your work today if you wish to secure anything above a subordinate position with low wages.

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Please explain without further obligation on my part, how I can qualify for a higher salary and advancement to the position before which I have marked X.

Electrical Engineer	Machine Designer	Sanitary Engineer
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Civil Engineer	Foreman Blacksmith	Chemist
Bridge Engineer	Marine Engineer	Sheet-Metal Draft.
Mechanical Engineer	Hydraulic Engineer	Ornamental Design.
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Refrigeration Eng.	Surveyor	Stenographer
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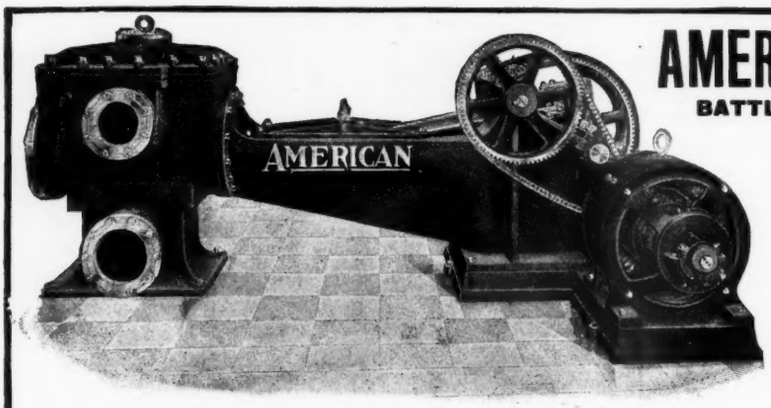
Name _____

St. and No. _____

City _____ *State* _____



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AMERICAN STEAM PUMP CO.

BATTLE CREEK, MICH., U. S. A.

Manufacturers of
MARSH and AMERICAN STEAM and POWER PUMPING MACHINERY for Every Service.

We make a specialty of VACUUM PUMPS, both STEAM and POWER, for heating systems.

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SIMPLEX NOT DUPLEX.

To be simple is to be great.

Alberger Condenser Co.

Condensers, Cooling Towers, Vacuum Pumps, Heaters

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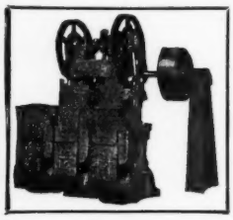
Centrifugal, Volute, and Turbine Pumps

Alberger Pump Co.

Deming

Ask for Catalogue "G" and treatise "Feeding Boilers."



For any service. **Power**

For operation by any power. **Pumps**

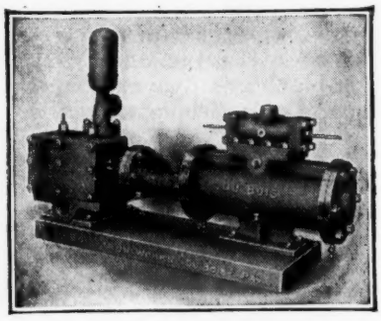
The Deming Company

Agencies in Principal Cities

Salem, Ohio

DuBois Pumps

"UNEQUALED FOR SIMPLICITY"



But one valve. No Outside valve gear to bend or bind. All working parts fully enclosed. Operation positive and noiseless. Highest economy, as there are no pockets for the steam to condense in.

Steam, Gas Engine and Motor Driven Types.

Capacities, 26 to 1000 gallons per minute.

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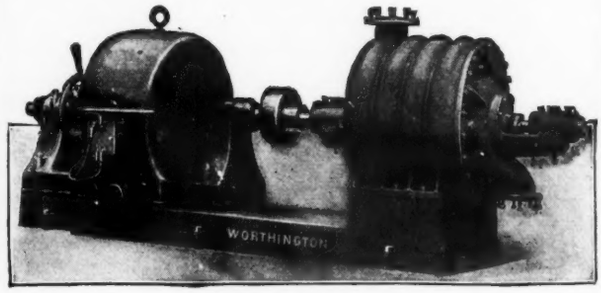
DU BOIS IRON WORKS

Established 1877

805 Brady Street Dubois, Penna.

OUR TURBINE PUMPS



ARE SIMPLE
RELIABLE
EFFICIENT
WELL CONSTRUCTED

Require very little attention.
Built to suit your conditions.

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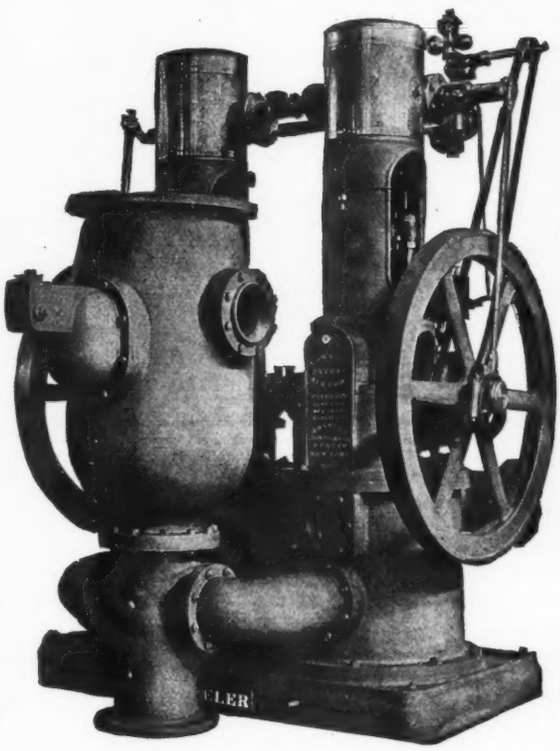
HENRY R. WORTHINGTON,

115 Broadway, New York City.



The Wheeler-Edwards Air Pump With Jet Condensers.

As the Wheeler-Edwards Air Pump handles both air and water, it is adapted for use with Jet as well as Surface Condensers. An outfit like that shown above will give a vacuum of 28 inches, suitable for steam turbine work, with injection water at 70° F. The removal of air is absolute and complete at each stroke of the pump.

As compared with direct-acting pumps this arrangement has the great advantage of using the steam expansively, thus considerably reducing the steam consumption for a given capacity. The steam cylinders can be compounded if desired. Because of the fly wheels the pump does not become stalled and there is no possibility of water backing up into the turbine or engine.

The fact that there is only one set of valves to take care of and that these are easily accessible by removing the cover plate shown in the picture makes these outfits easy to inspect and care for.

Wheeler-Edwards Air Pumps are built for steam, electric or belt drive and for direct connection to the engine.

Write for Treatise "P" on Air Pumps.

WHEELER
CONDENSER & ENGINEERING CO.
CARTERET, N. J.

(Builders of Wheeler Surface, Wet and Barometric Condensers, Wheeler-Volz Combined Surface Condensers and Feed Water Heater, Wheeler Feed Water Heaters, Barnard-Wheeler Cooling Towers, Wheeler-Edwards Air Pumps, Wheeler Centrifugal Pumps, Wheeler Rotative Dry Vacuum Pumps and Wheeler Multiple Effect and Evaporating Machinery).

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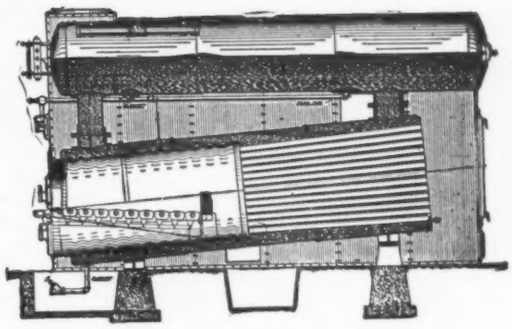
ROBB-MUMFORD



Internally Fired Boiler

Low first cost—Saving in fuel—Durable, Safe—Built in all sizes from 60 to 250 horsepower.

ROBB-MUMFORD BOILER COMPANY
SOUTH FRAMINGHAM, MASS.

New York Office, 90 West Street. Boston Office, 170 Summer Street.
Built in Canada by Robb Engineering Co., Ltd., Amherst, N. S.

Dean Bros. Steam Pump Works
INDIANAPOLIS

Simple Plunger Pump

Simple and Duplex Boiler Feeders. Jet and Surface Condensers. Power and Electric Pumps.

MOUND TOOLS. FOR THE ENGINE ROOM.

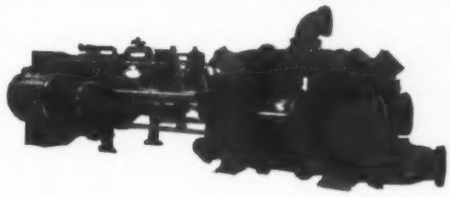
This cut represents our new set of 20 tools gotten up for use in the engine room. Strictly high-grade tools with all the good points of toolsmithing in their make-up. Conveniently arranged in finished Oak Case and every tool is guaranteed.

No. 20 Set of 20 Tools . . . $4.00.

Book "Engineers' Chums" free. Address Dept, B

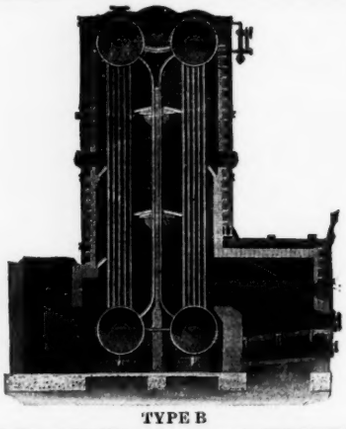
MOUND TOOL AND SCRAPER CO.
1606-1608 N. BROADWAY, ST. LOUIS, U. S. A.

Warren Steam Pump Co.
Warren, Mass.
PUMPS FOR ALL REQUIREMENTS.



Piston—Plunger—Hydraulic—Deep Well—Power.

Air Pumps and Jet Condensers, Combined Air and Circulating, and Marine. *Catalog.*



TYPE B

THE RUST
WATER TUBE
BOILER

SAFE, SIMPLE, DURABLE,
ECONOMICAL, ACCESSIBLE

Write for Report of Tests by William Kent.

THE RUST BOILER CO.,
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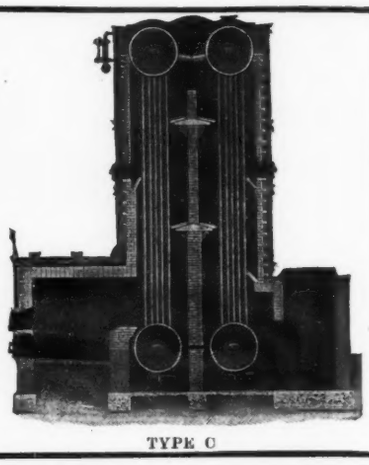
THE RUST ENGINEERING CO., Southern Agents | Birmingham, Ala. | New Orleans, La.



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PARKER BOILER CO.
WATER TUBE BOILERS—SUPERHEATERS.
PHILADELPHIA, PENNA.
New York—Pittsburg—Chicago—Denver—San Francisco.

Foster Superheaters

Increase capacity of boilers, give more power with less fuel, and prevent all loss and trouble due to wet steam.

POWER SPECIALTY CO.,
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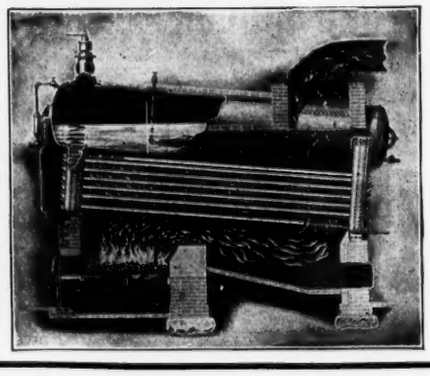
FRANKLIN WATER TUBE BOILER



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TROY, N.Y.

SALES OFFICE
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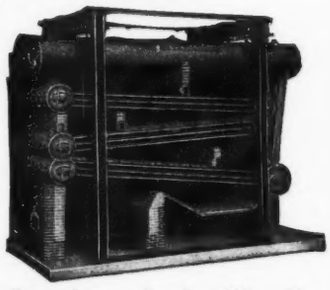
Steam Drums Are Not Chilled By Entering Feed Water

The water passes down the short vertical tubes to the mud drum, thence through three banks of tubes before it reaches the steam drum.



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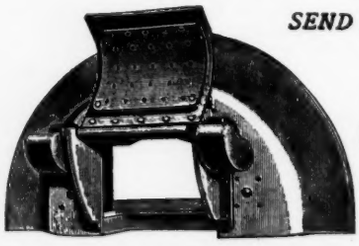
Protector Fire Fronts & Doors
For Land and Marine Boilers



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Near 10th and 23d Ferries
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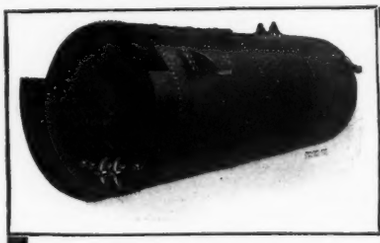

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Are Boilers of CHARACTER

They bear the mark of superiority. They are built by mechanics, are strong, solid, substantial, efficient, durable. Have the name KEWANEE in your specifications.

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Edge Moor Boilers
—WATER TUBE—
EDGE MOOR IRON CO., Edge Moor, Delaware

Inquire About 800 H. P. Units.

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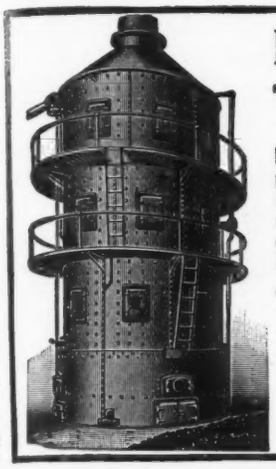

Fuel Economy

THE large heating surface of the CLIMAX BOILER and its ability to utilize every particle of heat enable it to produce more steam per pound of coal than any other type or make. It supplies steam absolutely dry and superheated to over 80 degrees. Full description in our booklet. Write.

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Main Offices: 250 Lorraine Street.

Works:
Smith, Lorraine, Court and Creamer Streets
Telephone, 243 Hamilton.

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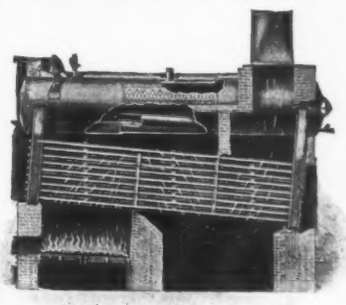

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STEAM SUPERHEATERS—MECHANICAL STOKERS

Barberton, Ohio — WORKS — Bayonne, N. J.

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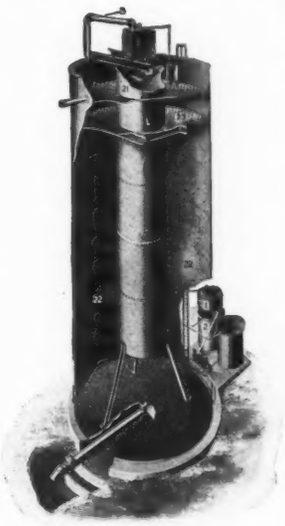
Scale Forming Boiler Feed Water

Can be made soft and clear for from

1 to 2 Cents Per 1000 Gallons

by the use of

The Bartlett Water Softener



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Its results are guaranteed.

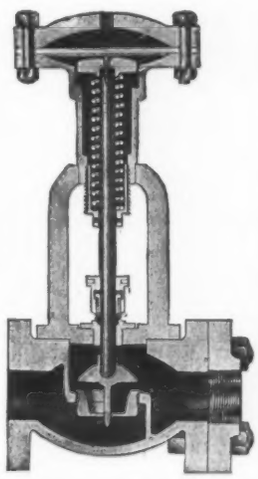
NORTHERN WATER SOFTENER CO.
Madison, Wisconsin

4/S PUMP GOVERNOR

(Class H)

is a single-seated simple governor, built extra heavy, and will regulate the pump at any pressure greater than 10 pounds.

Is very simple to adjust and has nothing to get out of order.



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AND SUPERHEATERS

All Flange Steel Construction

Send for { Boiler Logic and Superheater Logic

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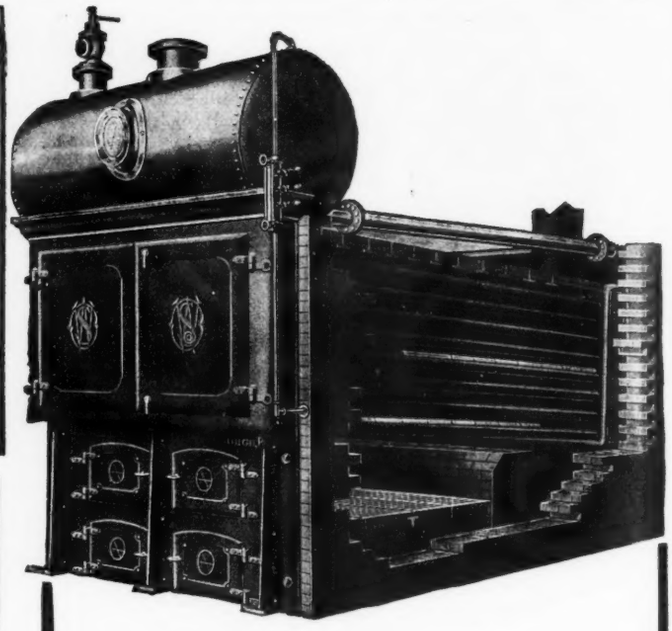

The World's Best Pump Governor

is the "FISHER."

In design, material and workmanship it stands alone. In efficiency, durability, simplicity, convenience and safety it has established a "never-equaled record." Yours on 30 days' trial—full guaranteed.

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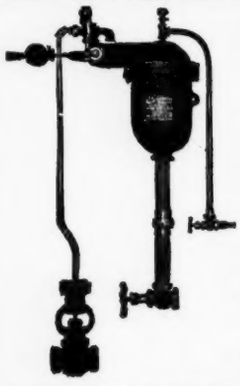
The Fisher Governor Co.
Marshalltown, Iowa.



The Vigilant Feed-Water Regulator

for steam boilers was the first in the *field*, and has the longest and best record of any of these devices.

Costs Less to Operate and Maintain

Constructed on a different and better principle than any other.
Investigate it and the

FULTON PUMP GOVERNOR

and send for latest catalogue with list of users.
A guarantee from a responsible firm with every machine.

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THE BERRY Safety Automatic Feed Water REGULATOR

Send for Catalogue

BERRY ENGINEERING COMPANY
Chester, Penn.

Metropolitan Office, 136 Liberty St., New York City.

The Basis Of Economy

in any power plant is the boiler system. If you appreciate that fact you will do well to investigate

Our Safety Water Tube Boiler

Built for any pressure from 125 to 300 pounds. Meets all the high duty requirements of modern triple and quadruple expansion and compound engines. Perfect circulation, remarkable economy, and freedom to expand and contract, are features.

Ask for illustrated catalog and latest test report.

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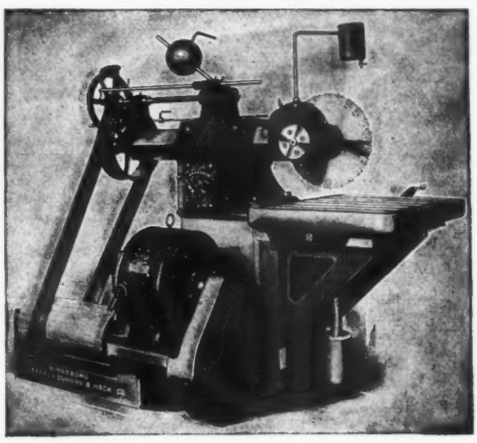
INDIVIDUAL-MOTOR DRIVE



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The load on a machine is rarely at a maximum,

it usually varies from 40 to 80 per cent., according to the class of work. With mechanical drive the shafting and belting must be of a capacity to take care of the maximum load, making the friction load often as much, or more, than the load on the machine. With direct-connected motors there are no losses when the machine is idle, and when in operation power only is required in proportion to the actual work being done by the machine.

See booklet No. 24, "Your Power Problem."

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Atlanta, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Kansas City, Los Angeles, Minneapolis, New Orleans, New York, Philadelphia, Pittsburg, St. Louis, Salt Lake City, San Francisco, Seattle, Syracuse

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INDUCTION
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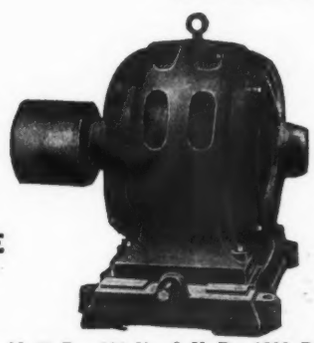
HIGH EFFICIENCY
HIGH POWER FACTOR
COOL RUNNING

2 AND 3 PHASE



1 TO 75 H. P.

10 H. P., 220 V., 3 H. P., 1200 R. P. M.

Triumph Electric Co.,

Main Office and Works:
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BRANCHES IN ALL LARGE CITIES

Know Your Ice Machine.

Practical Knowledge is necessary to get results from the ice plant you operate. We claim that the Triumph operates more economically than any other ice machine made. We help the engineer prove our claim while showing his own ability.

"Triumph Originality" is the book we have prepared to help the engineer; write for a free copy, stating that you are an engineer.

Remember

The Fittings That Don't Leak.

The Triumph Ice Machine Co.

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Weiss Counter-Current Condenser.

We are sole licensees in the United States for the manufacture and sale of this Condenser, and will gladly send particulars to any one interested.

We guarantee any desired vacuum, using less cooling water and of higher temperature than other apparatus.

All contracts made upon positive statements as to relative volume of steam and water.

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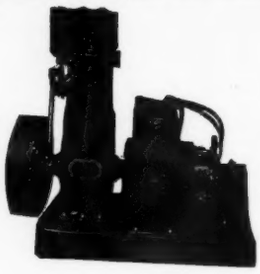
ENGBERG'S Compact Generating Set.

Especially adapted for isolated buildings and factories.



Its use insures the best possible system of illumination at minimum cost. Can be operated with a small expenditure of steam and with very little attention from the engineer.

If you can use from 30 to 500 better lights at less cost, this machine should be in your plant.

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Engberg's Electric and Mechanical Works.
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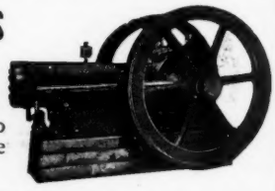
FOOS GAS ENGINES

appeal most to the man who has operated gas engines, for such experience enables him to more carefully judge its good features.

Write for Catalog K and learn all about the Foos

PRODUCER GAS PLANTS
25 TO 500 HORSE POWER
Complete Waterworks Plants
Complete Electric Plants



You could lose more than we do if you do not investigate The Foos.

THE FOOS GAS ENGINE CO., Springfield, Ohio

ENGINE AND BOILER BARGAINS

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20 x 42 Allis, Corliss	16 x 32 Buckeye, Automatic
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Also large assortment of Automatic and Throttling Engines of other sizes.

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84 x 18, 78 x 16, 72 x 18 High Pressure, 72 x 16, 66 x 16 and smaller sizes of Horizontal Tubular Boilers, also Vertical and Fire Box Boilers from 5 to 60 H. P.

Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc.
Write for bargain list.

We are the sole manufacturers of the celebrated "Leader" Injectors and Jet Pumps.

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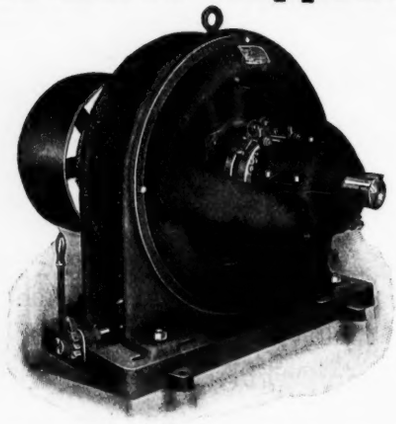
A Direct Appeal



Type TRB Three-phase Belted Alternator, Form B

To every electric lighting plant in the country that is in need of additional generating capacity. Write for our special Bulletin 1104, which describes our Form B multiphase belted alternator, designed specially to fit your conditions and meet your requirements. It meets *your* requirements because we have studied *your* problems and know.

Ask for the Bulletin Now 706

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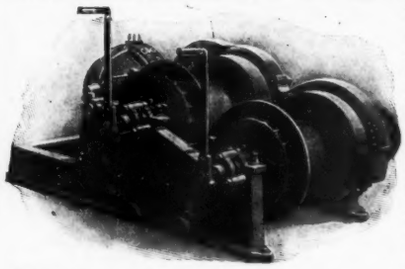
CROCKER-WHEELER COMPANY
Ampere, N. J.

This Hoist is Electrically Driven by a C & C MOTOR



Notice how compact the outfit is—how out of the way the motor is, and how entirely protected it is by its casing.
At the same time this motor is perfectly accessible in every part and has the characteristic C & C merits, such as low temperature rise, capacity for heavy overloads, and freedom from noise and vibration.
Our CRANE MOTORS are just the thing for Running Skull Crackers. Try them!

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STANDARD AND SPECIAL ELECTRICAL MACHINERY.

ALBERGER TANDEM GAS ENGINES

ACCURATE REGULATION FOR ELECTRIC SERVICE-AUTOMATIC CUT-OFF AND RITES FLY-WHEEL GOVERNOR

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45 TO 600 H.P. USING NATURAL GAS
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You should always know the heat value of the gas you use.
The Sargent Gas Calorimeter is as essential to the Gas Engineer as the indicator is to the Steam Engineer.
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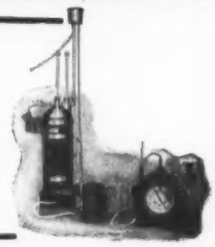

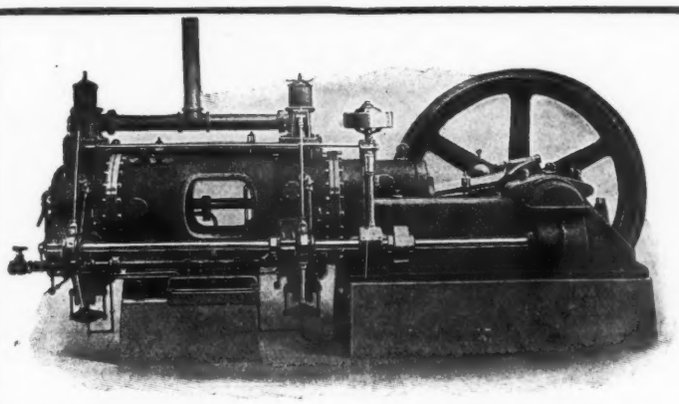

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NOT AN EXPERIMENT

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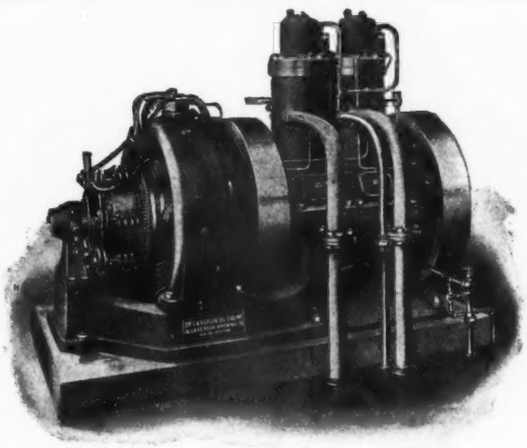

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OIL ENGINES

are cheaper, simpler, more compact than any other motive power. 8 H. P. hours per gallon of cheap oil.

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The "De La Vergne" Vertical two-Cycle 4 to 25 H. P.
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DE LA VERGNE MACHINE CO.

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One 50 H. P. Amsler Suction Gas Producer, located at Birmingham, Alabama.

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Both producers have never been used and are absolutely new.

A bargain to any one who is in need of an economical power generating plant.

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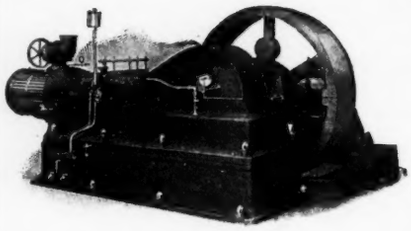

SIDE CRANK TYPE

CENTER CRANK
SIDE CRANK
SINGLE and FOUR VALVE

Skinner Engine Co.,
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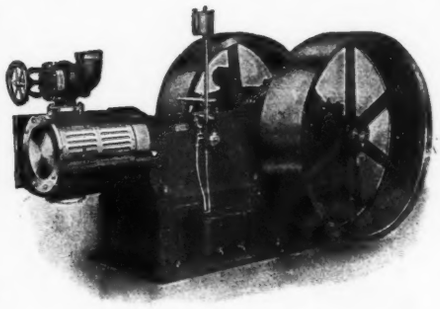

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BUCKEYE ENGINE COMPANY,
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BUILDERS OF HIGH CLASS

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HIGH IN DUTY, SUPERIOR IN REGULATION
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ABSOLUTELY RELIABLE

CORRESPOND WITH US BEFORE PURCHASING
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Reeves Engines have proven their superiority, two standard compounds and one standard single cylinder engines were tested at Cornell University. These tests speak for themselves. Let us tell you more about it.

REEVES ENGINE & MACHINE CO.
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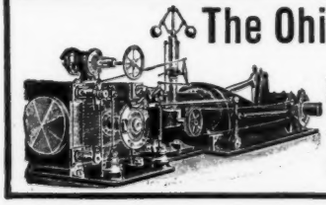
The Ohio Corliss Engine



For hard work, heavy loads and high-speed, the Ohio shows close regulation and runs smoothly and quietly.

THE GRIFFITH & WEDGE CO.
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RICE & SARGENT
CORLISS ENGINES
For Reliability and Economy.
Built by
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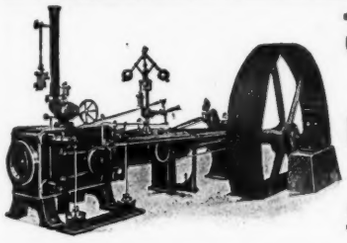

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Refrigerating and Ice Making Machinery
THE VILTER MFG. CO.
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When you do change, change for the better and get a
Shepherd Engine
It gives "quality," power and economical service, at a minimum cost. Your first outlay is really your ONLY expense. Our booklet will interest you.
Shepherd Engineering Co.,
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We Manufacture
AN ECONOMICAL AND DURABLE ROTARY ENGINE
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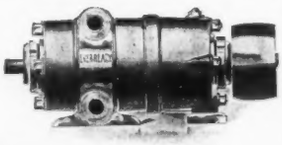

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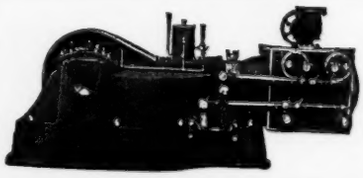

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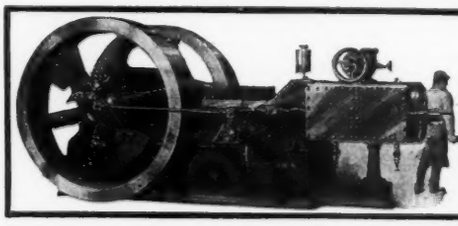

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for every power purpose. Ask for Catalog.
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CORLISS ENGINES

BERRY SAFETY **BOILERS** POWER PLANTS

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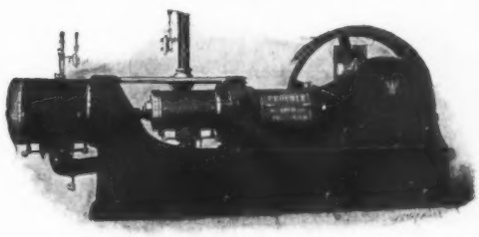
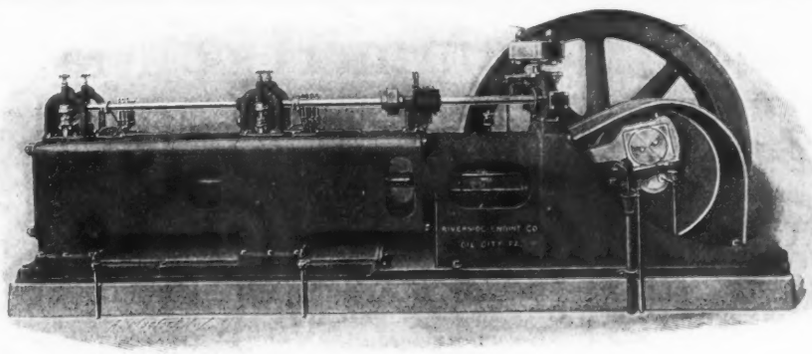


General Offices and Works: - - MEADVILLE, PA.



Riverside Heavy Duty Single Acting Tandem Gas Engine (Class C)

RIVERSIDE

Engines are the standard American Gas Engine. They have the reliability of a steam engine, the greatest accessibility, are extremely simple and are economical to operate.

Built in all types, single cylinder, single acting to twin tandem double acting, 40 to 2,500 H. P.

Riverside Engine Co., Oil City, Pa.

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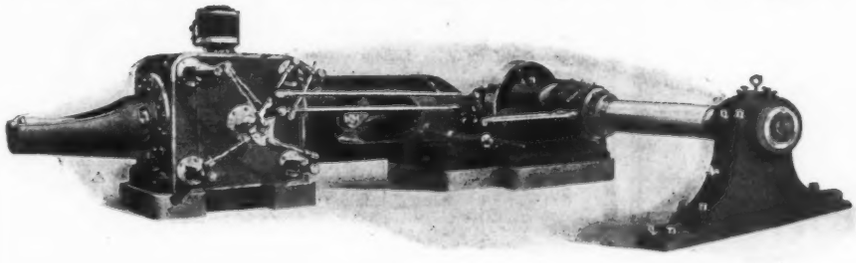

This engine is unequaled for highest speeds and pressures. The cost per engine horse power and generator cost are remarkably low. In simple, tandem and cross compound units, and for rotative speeds up to 200 R.P.M. Piston speed up to 900 feet. Maximum economy and perfect regulation are guaranteed.

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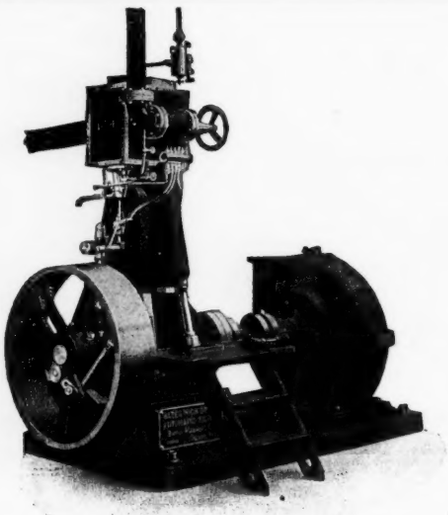

Bates Vertical Automatic High Speed Engine for connection to Pumps. Especially adapted for

WATER WORKS, IRRIGATION

and other places where it is desired to move a large volume of water at small expense.

CATALOG FOR THE ASKING.

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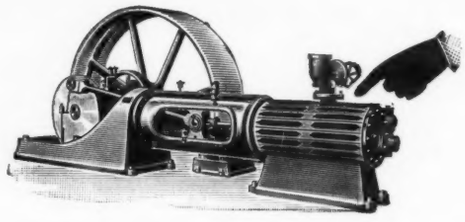
In Thousands Of Modern Plants

you'll find Fitchburg Engines saving steam, economizing on fuel and remaining steam tight with but one hour's attention per year. This continues for a *quarter of a century.*

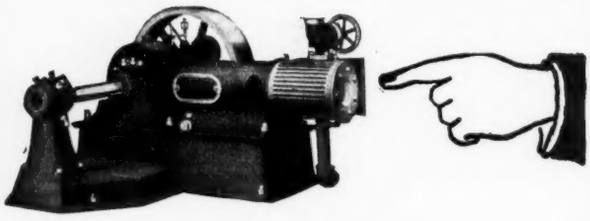
If Fitchburg Engines are not found in YOUR PLANT, you're not getting the satisfaction and economy you should. Catalog?



Fitchburg Steam Engine Co.,
Fitchburg, Mass.

E. H. Ludeman & Co., 165 Broadway, New York. H. J. Gebhardt, 1419 Fisher Building, Chicago. Geo. H. Conner, 509 Mutual Life Building Philadelphia, Pa. W. C. Teas, Chattanooga, Tennessee.

Perfect Alignment



THE FRAMES OF

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are bored out, the bearings for pillow blocks spotted and the frame ends faced, all at one setting. Get our illustrated catalog for further facts.

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Engineers and Machinists

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WE MAKE A SPECIALTY OF

Corliss Engine Repairs. Engines Indicated.
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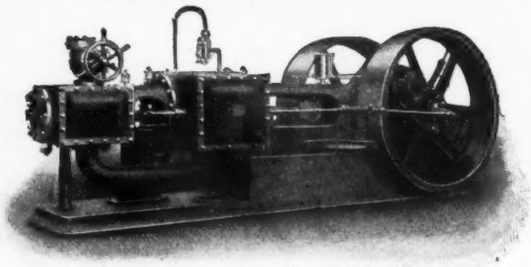
Not One Revolution Slower



When fully loaded than when running light. *Catalog?*

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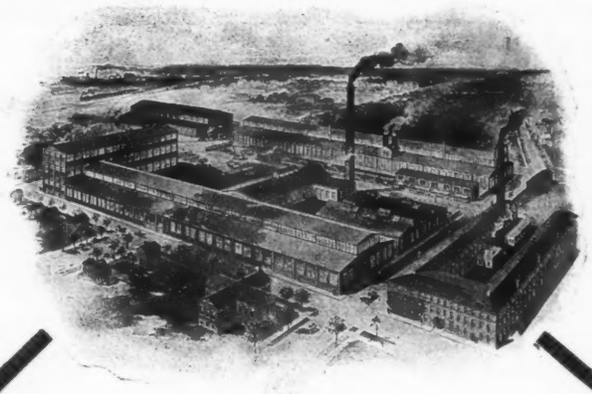
WORKS: RIDGWAY, PA., U. S. A.



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We build engines for Rolling Mill, Railway, Lighting, and general Power Plant service.

Complete Steam Plant Engineering a specialty.

THE C. & G. COOPER CO.,

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ON A MINUTE'S NOTICE

We have for immediate delivery:

One 18-inch by 42-inch girder frame engine, left hand, 90 revolutions, rated at 250 h.p.; wheel 14-ft. diameter by 48-inch face.

One 19-inch by 42-inch girder frame engine, right hand, 100 revolutions, rated at 280 h.p.; wheel 14-ft. diameter by 33-inch face.

The above are **new** engines.

One 14-ft. diameter by 28-inch face pulley, turned for belt. Hub bored 11-inches diameter. Wheel weighs 15,000 pounds.

Get busy and communicate with us.

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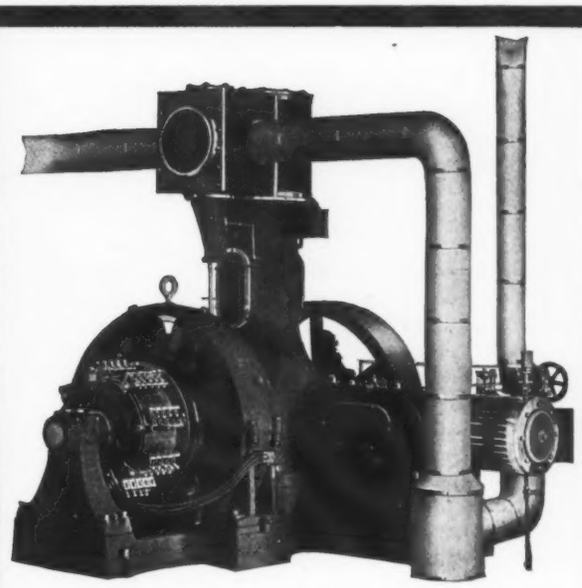
Chicago Representative—FRANK H. POND & Co., Fisher Bldg.



The Engine For Driving Alternators

Where two alternating current electrical generators are run in parallel, their efficiency and regulation depend upon other things than the generators themselves. If the two generators are driven by engines of different types, or even by two ordinary engines of the same size and type but with the piston not moving in unison, cross-currents are set up, which waste power, reduce the capacity of the generator and interfere with the voltage regulation.

The desirable condition, therefore, in alternator driving is to have the turning moment of the prime mover absolutely uniform throughout a revolution. This can be attained, together with perfect conditions for balancing and high steam economy and in the least possible space, by setting the cylinders at right angles, so that the greatest effort of the one occurs at the time of the least effort of the other, resulting in a practically uniform turning moment throughout the revolution.

This is one of the advantages of the American-Ball Compound Engine. Other advantages realized at the same time are smooth, quiet running, small foundations and floor space and excellent regulation.

Write for our Treatise on Compounds.

American Engine Co.,

21 Raritan Ave. Bound Brook, N. J.

14

Small Curtis Turbine Generators

The simplicity of the Curtis Turbine is not alone a feature of construction. It also contributes to valuable operating advantages. There are no internal wearing parts to cause a decrease in efficiency, after long periods of operation. Compare the view below of the working parts of the turbine with the corresponding parts of a steam engine and calculate the expense of piston packing, reboring cylinders, valve grinding and bearing linings for an engine which are avoided in the Curtis Turbine.

Wheels and shaft of 75 kilowatt Curtis Turbine in position in lower half of wheel casing

And remember that no injury is done if the Curtis Turbine is flooded with water while in operation, and that it may be brought up to speed ready to carry the load almost instantly without the warming-up, draining, etc., customary with the reciprocating steam engine.
If you need more power tell us what you have and we will tell you more about these small turbine sets.

General Electric Company

Principal Office: SCHENECTADY, N. Y.

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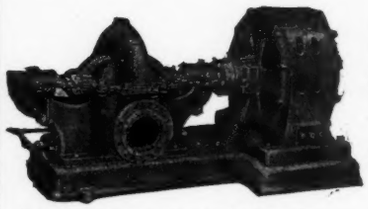
Sales Offices in all large cities

1790

DE LAVAL



De Laval A. C. Motor-Driven Pump.

Steam Turbine Motors
Steam Turbine Dynamos
Steam Turbine Blowers
Steam Turbine Centrifugal Pumps
Electric-Motor Centrifugal Pumps

Send for Catalog No. 20.

DE LAVAL STEAM TURBINE CO., Trenton, N.J.

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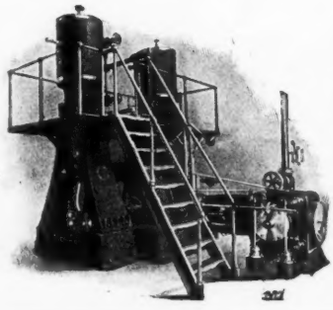
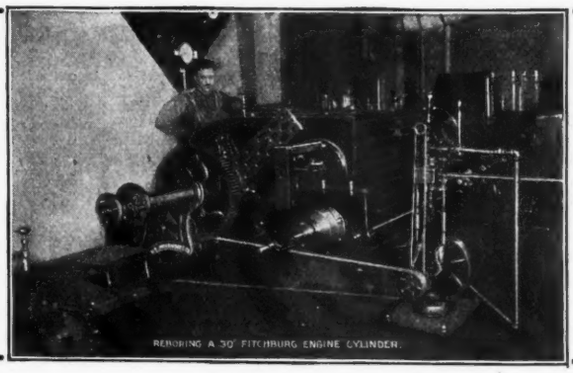


We manufacture all machinery and parts needed to equip a complete Ice or Refrigerating plant—

Machines, Condensers, Tanks, Cans, Coolers, Piping, Boilers and Ammonia Fittings.

of all kinds. We employ over 1,250 men in the manufacture of Ice and Refrigerating Machinery exclusively. Catalogue sent upon request.

A Small Fraction Of The Usual Cost



RENORING A 30" FITCHBURG ENGINE CYLINDER.

The Underwood method of engine repairing enables your engine to run right up to the minute when we start work and to start up the minute the work is finished. Thus we save a lot of time and express charges as well as dismantling and resetting costs.

Write.

AMMONIA CYLINDERS INDICATED

H. B. UNDERWOOD & CO.,

ESTABLISHED 1870

1021 Hamilton St., Philadelphia, Pa.

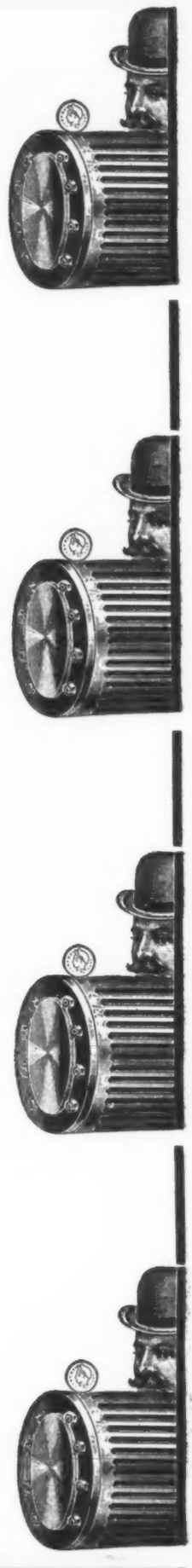
Steam Line *versus* Line Shaft

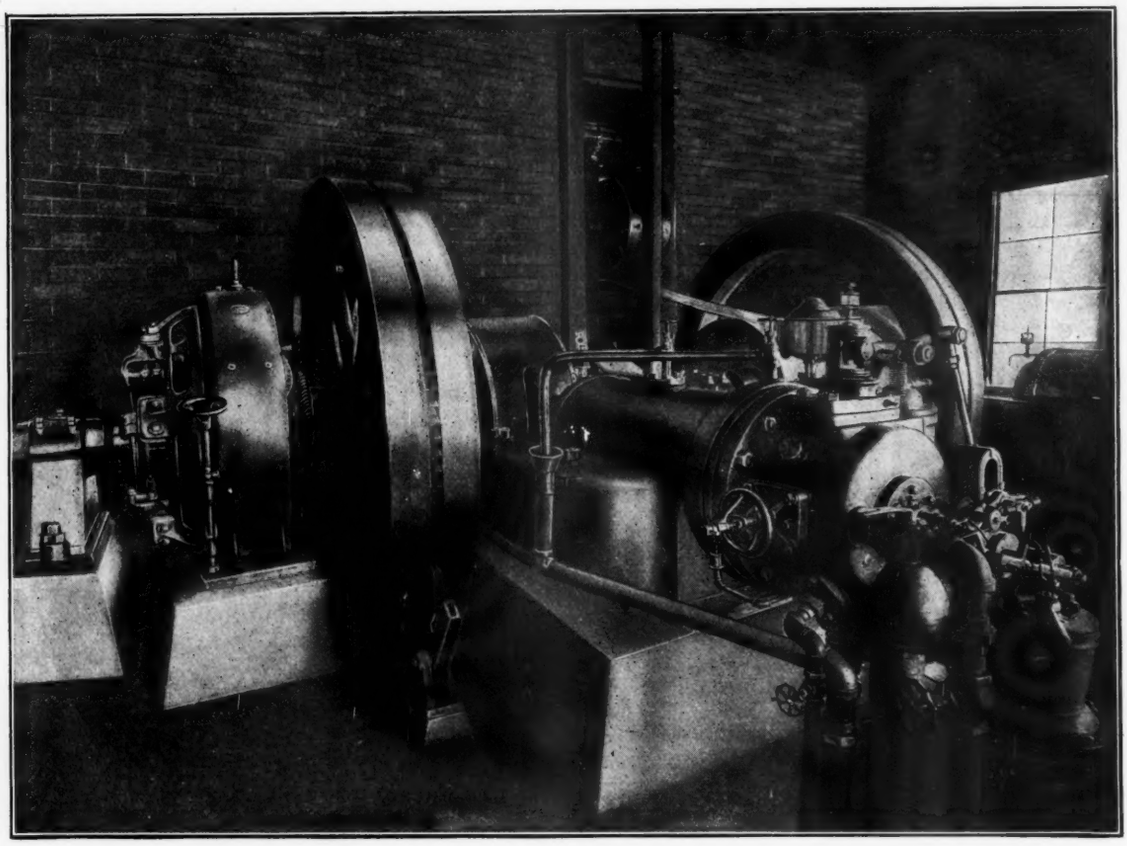
Modern engineering practice is more *steam-line* and less *line-shaft*—smaller units advantageuosly placed, versus the single large unit with its endless shafting, friction, belts and pulleys. Other advantages are:—freedom in locating machinery, elimination of complete breakdown, and variable rates of speed direct from the prime-mover

IDEALS

are pre-eminently adapted for this purpose, they are automatic,—run in oil—and require practically no attention.

A. L. IDE & SONS,
Springfield, Ill.





Nuenzel Gas Engine and Suction Producer Plant

The above cut shows one of the direct connected units in the Power Plant of the M. & St. L. R'y shops—where we have four different Engines.

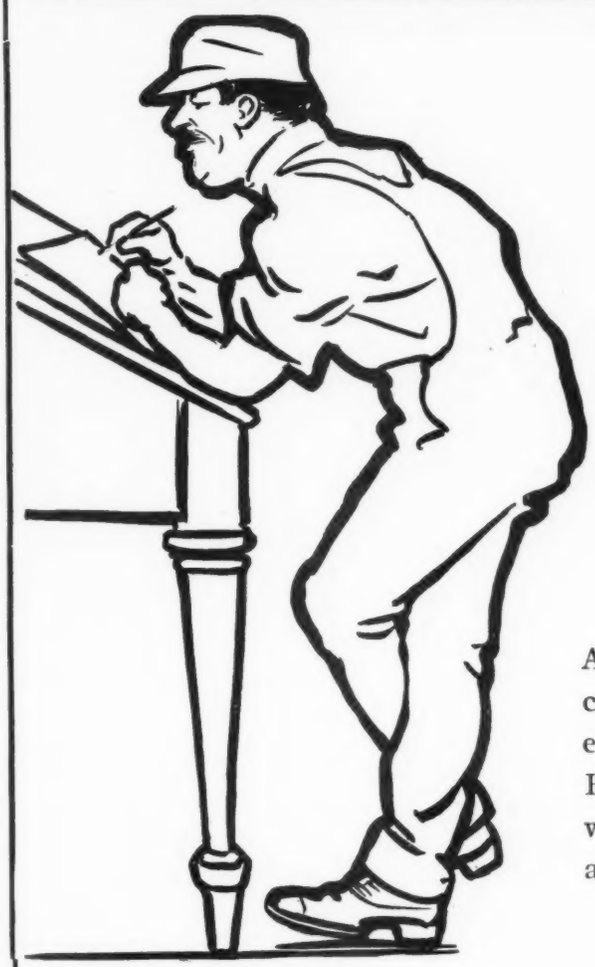
"This Engine ran day and night without a single stop for 92 days—when shut down for examination was in perfect condition."—*From operator's report.*

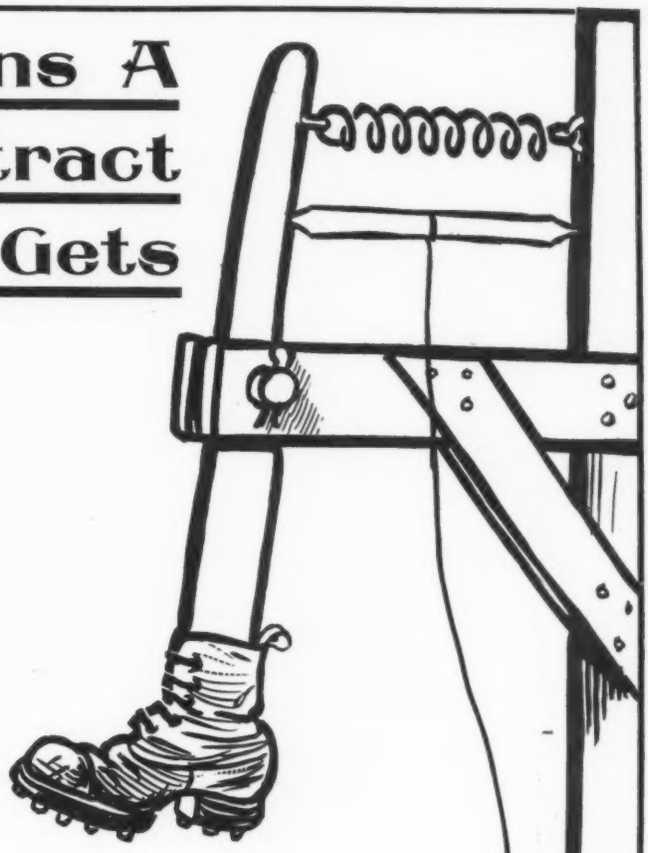
How about reliability?

Minneapolis Steel and Machinery Co.,

Minneapolis, Minn.

A Man Who Signs A Yearly Oil Contract Deserves All He Gets





And the man who signs a yearly contract does **not** get economical or efficient lubrication for his engines. He ties himself up to a lubricant that wastes itself, that is dirty, and that allows friction to eat up his profits.

KEYSTONE GREASE

on the other hand outlasts oil 50 times over; it practically annihilates friction; does not spatter or melt and run out of bearings; contains no fats, rosin, acid, graphite, talc, etc. "Keystone" is the perfect lubricant. Think twice before you sign the yearly oil contract.

KEYSTONE TRADE MARK REGISTERED U.S. PAT. OFF.

KEYSTONE TRADE MARK REGISTERED U.S. PAT. OFF.

See our advertisement on Page 3.

Keystone Lubricating Co.

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NO IMITATIONS FOR ME.

I have used PALMETTO braided and twist Packings for years, and know that there are no packings like them for high steam and air pressures, and I don't intend using any substitute in order that some dealer may make an unusual profit at my expense.

I look carefully at each box for the red tin tag which I have found is to piston rod packing what the word "Sterling" is on Silverwear (highest grade of uniform quality).

I was led to adopt PALMETTO PACKINGS as a standard by sending to GREENE, TWEED & CO., the sole manufacturers, at 109 Duane Street, New York, for FREE working samples, which proved all they claimed for them.

I advise you, Brother Engineer, to do as I did and be sure you buy no imitations.

WISE ENGINEER.

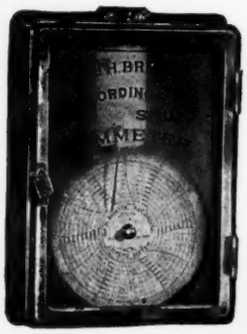
THE BRISTOL COMPANY

SPECIALISTS IN

Recording Instruments

FOR

PRESSURE
TEMPERATURE
AND
ELECTRICITY



Wm. H. Bristol Recording Shunt Ammeters
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Bristol's Recording Pressure And Vacuum Gauges For Power Plants

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SPEED INDICATORS

OR REVOLUTION COUNTERS

No. 104.—This indicator may be run at the highest speed required without heating. The working parts are encased. Dial has two rows of figures, reading right or left as the shaft may run. Steel pointed spindle with rubber tips for both pointed and centered shafts. The (0) mark may be instantly set at starting point.

Price, Postpaid, $1.00

No. 107.—Has all the good points of the above, and in addition has a hard rubber handle for insulation when used on electrical machinery. It also automatically registers the number of revolutions up to 5,000, thus relieving the mind from keeping count.

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Send for Free Catalogue, No. 17-R, of Fine Tools.

The L. S. Starrett Co.

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